the Cornell engineer

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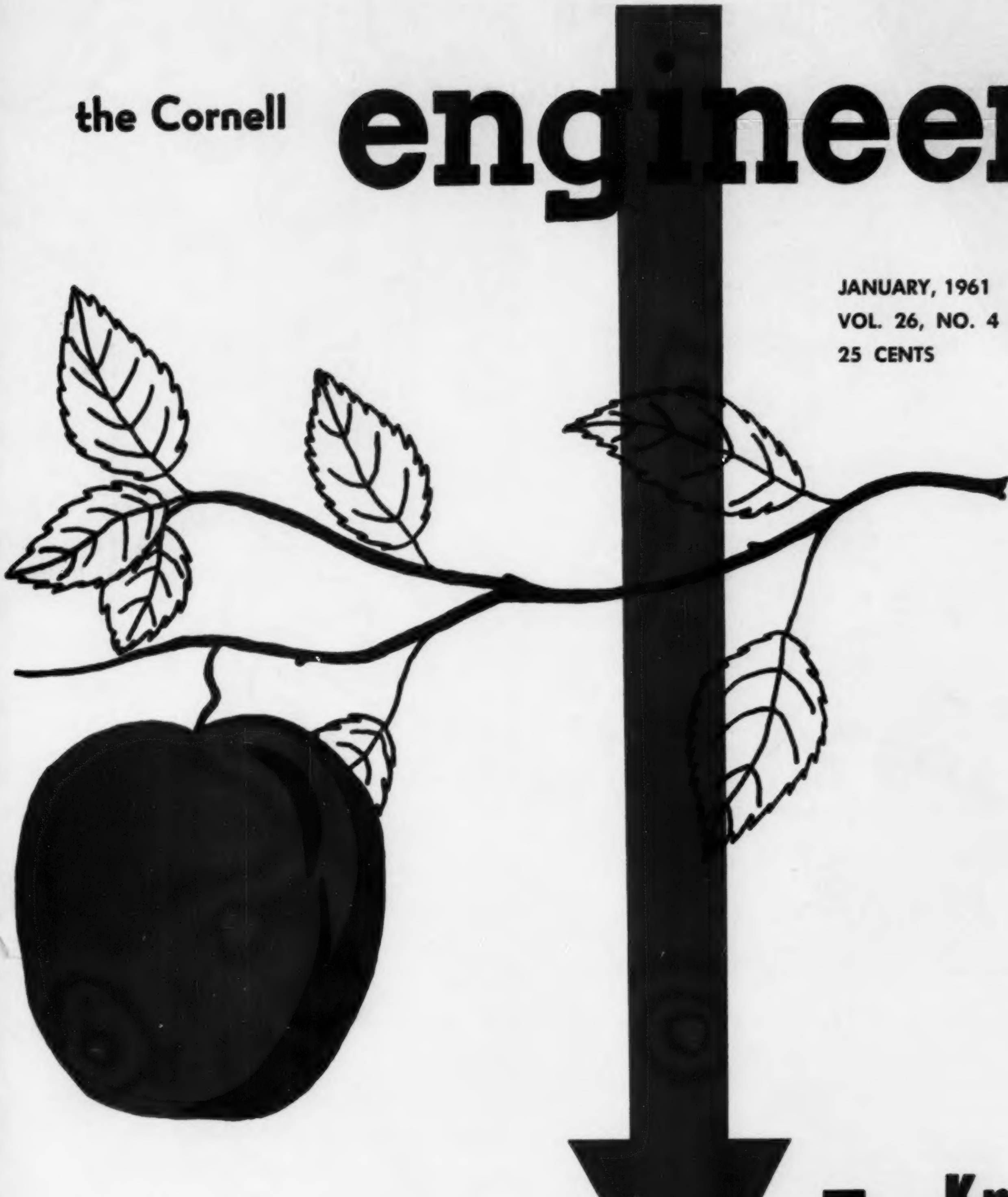

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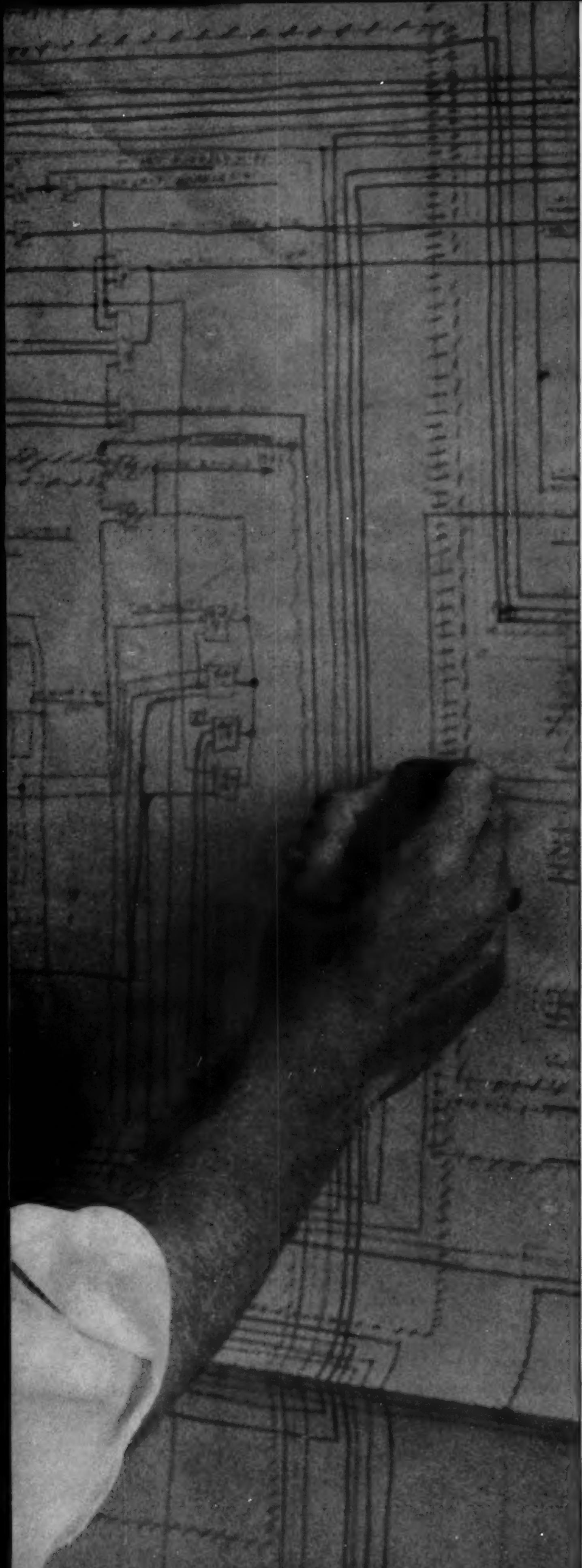

the Cornell **engineer**

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TECHNICAL EDUCATION AND RESEARCH IN INDIA

by Professor Michel G. Malti

Editor's Note:

The International Cooperation Administration (I.C.A.), Washington, D.C., which is a division of the U.S. Department of State, instituted a plan in 1959 to aid technical education in India. This plan calls for selecting, over a period of three years, some three hundred and fifty educators from India's technical institutes and universities, and sending them to universities in the United States to engage in graduate study and research.

The College of Engineering at Cornell has cooperated fully in this program. In the past three years, over fifty educators from India have been graduate students in the various branches of engineering. Some of them have returned to India, carrying Cornell degrees. Others are still on our campus, completing the requirements for Master's or Ph.D. degrees. Reports from all schools of the College of Engineering show enthusiasm over the program, and the excellent selection of Indian Educators who have participated in it.

Professor Michel G. Malti, of the School of Electrical Engineering, is Coordinator of this I.C.A. Program at Cornell University. He spent two years (1955–57) as a Visiting Professor in the University of Roorkee, India. We asked him to give us his views about technical education and research in India, and he kindly responded with the following article.

My knowledge of technical education in India was acquired through a two year (1955–57) tour of duty at the University of Roorkee, Roorkee, U. P. India, under a contract between Rensselaer Polytechnic Institute, Troy, N.Y. and the International Cooperation Administration, Washingon, D.C.

During these two years I lectured for periods varying from four days to four weeks at the following educational institutions: Indian Institute of Science, Bangalore, Mysore State; Birla College of Engineering, Pilani, Rajasthan State; M. B. M. College of Engineering, Jodhpur, Rajasthan State; and Bihar Institute of Technology, Sindri, Bihar State. While these are by no means the only technical institutions, they are certainly typical and afford a fairly good sample of engineering education in India.

It should be here emphasized that *India is not a backward country*. The University of Roorkee is over 110 years old and counts among its alumni some of the most distinguished world authorities in civil engineering, particularly in irrigation and the development of water resources. Ever since India became independent the number of Indian universities has almost doubled from 18 before independence (1946) to 33 as of 1954, and the end is not yet in sight. The output of engineering graduates has risen from 1,000 before independence to 4,000 in 1954. Just before I left India the universities were expanding their facilities to double this latter number by 1960.

Technical institutes were built, equipped and put into operation within a span of a few years. Among these are the Indian Institute of Technology at Karagpur, West Bengal State, which started functioning in 1952, Bihar Institute of Technology at Sindri Bihar State, established a year later, and M. B. M. Engineering College a year later at Jodhpur, Rajasthan State.

Nor is there any lack of leadership in education. Dr. A. N. Khosla, Vice Chancellor of Roorkee University,[1] with whom I had the privilege of intimate association during my tour of duty in India, is not only an engineer of international reputation but is also a man of vision, an enthusiastic Indian patriot, a friend of the United States, and a highly efficient executive. Dr. Deshpande, Principal of Bihar Institute of Technology, is the founder of that Institute. He cleared the ground of trees, planned and constructed the campus, selected teachers, and put it into operation. Professor Garde of M.B.M. College, Jodhpur, left his professorship at Roorkee University to found that college and, like Dr. Deshpande, built it from the ground up. Principal Lakshminarayanan, Birla College of Engineering, is another pioneer who planned that college and now supervises its activities. All these men and many others like them are a source of hope for the rapid and intelligent progress of engineering education in India.

India's constitution is similar to that of the United States. India has a Union Government (federal government) and 28 state governments. Educational institutions within a state (except the few private institutions) are generally supported partly by that State Government and partly by the Union Government. Others, like the Indian Institute of Technology at Karagpur and several research institutes, are supported by the Union Government. Both the Union Government and the state governments have been generous in their support of education and research. The Union Government of India spent in 1954 over 244 million rupees (about 50 million dollars) on higher education. This constitutes 5% of the total expenditures of the Union Government. Converted into terms of our budget this represents 3.5 billion dollars which might have been appropriated for higher education by our Federal Government of which alas! only about 280 million dollars was spent in aid to higher education in the United States in 1954.

Finally, the Ministry of Education in the Union Goverment and the various ministries of education in the state governments are awake to the value of education in general and technical education in particular. These ministries are led by men some of whom I was privileged to know. They impressed me with their ability and their dedication to the service of their country.

We might therefore conclude that on the whole the outlook for

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Professor Michael G. Malti

Professor Michel G. Malti, of the School of Electrical Engineering, has distinguished himself in his work as an educator and by his contributions to electrical theory and applied mathematics. He has written a number of books and articles dealing with the applications of physics and math to electrical theory. As an engineer, he has done considerable work on dielectrics, circuit analysis, and the analysis of rotating machines.

Born at Deirul-Kamar, Lebanon, he attended the American University of Beirut and received an A.B. degree in 1915. He then spent one year teaching in the preparatory department of the University before travelling to America and joining the cooperative program at Georgia Institute of Technology. Professor Malti received his B.S. in E.E. from Georgia and then wrote to the graduate school of Cornell. He received his M.E.E. degree from Cornell in 1925 and his Ph.D. in 1927.

Since that time, he has written texts on electrical circuit analysis and Heaviside operational analysis as well as some thirty papers representing his research in various fields of electrical engineering. Professor Malti was recently elected a fellow of the American Institute of Electrical Engineers.

technical education in India is very bright indeed. Let us now discuss the subject in great detail.

Students

Like all countries which have been recently liberated from foreign domination, India realizes that its future depends upon its industrialization. This realization is universal. Hence it is easy to understand why to every available student vacancy in technical schools there exist anywhere between twenty and thirty applicants. In order to use the facilities of technical institutions to the best interest of the nation, Indian universities adopt the competitive entrance examination system. Sometimes in the early spring the registrar of a university advertises in the newspapers the date and the place of the competitive examination and solicits applications from all those who wish to compete. The competitive examination covers the physical sciences, mathematics and English (English is at present the language used for all technical education in India). The examinations are corrected, the standing of the student is determined by the grade he makes, and the number of men who can be admitted (from 3% to 5% of those examined) is taken from those whose grades head the list.

This system of student selection results in a high mentality of the student body. It unfortunately excludes students who, although not possessing the mental qualifications, have other desirable qualities for success and who could, perhaps, be picked if part of the examination was directed toward the discovery of such qualities in the prospective student. It is the author's opinion that some excellent material is lost to the Indian nation through this inequitable selection of the student body.

In spite of its defects this selective system results in an excellent student body. The students are alert, responsive, and hard working. Moreover, unlike American universities, Indian universities do not suffer from a high rate of attrition. Thus, whereas in the United States some 60% of the freshmen do graduate, almost 100% of the students entering Indian universities get their degrees or diplomas. Those who do not graduate fail because of economic or health reasons rather than for scholastic inaptitude.

Another factor which contributes to better scholarship among university students in India is the absence of distractions. Thus, there are no weekly football games, no basketball games, no national or collegiate baseball games, no dates with girls, no fraternity activities, no television, a very slight amount of radio, very few magazines and on the whole very little to distract a student from his studies. It is not the author's intention here to pronounce these distractions as positively harmful to the students. Indeed it should be emphasized that extracurricular activities have a useful and vital place in the life of a student. They tend to develop qualities among our students which give them balance and maturity. However, some American students lay too much stress on these activities and too little on their scholarly pursuits. It is these students who fail in their work and contribute to the high rate of attrition in American universities. It must not be concluded from this that the university student in India does nothing but study. Games and sports are an integral part of every university. The students play tennis and squash. They have occasional football matches (Rugby type). They swim and even row boats. They have annual athletic meets which last a few hours. These sports, although encouraged by the universities, are neither highly organized nor are they income-producing. There is no hero worship of athletes in Indian universities.

One important difference exists between the American student and the Indian student. Whereas the American student welcomes menial labor the Indian student shuns it like the plague. The reason for this is that menial labor is done by a caste far inferior to that from which the student body is generally drawn. A student performing menial work automatically steps down to that lower caste. The caste system is quickly vanishing in India. Through the efforts of Ghandi, Nehru and other leaders who recognize its faults, the caste system has been abolished by legislation. It is, however, not easy to abolish a custom thousands of years old on which the very structure of a society is built. Hence wise administrators, such as the Vice Chancellor of Roorkee University, have introduced Shramdan (voluntary labor) in order to give a practical application of these laws in Indian universities. Shramdan requires every Indian student to do voluntary menial labor as an extra-curricular activity. One of the tangible results of Shramdan in the University of Roorkee is an addition to the Student's Club building which has doubled its floor capacity and which was done exclusively by student labor supervised by members of the faculty. Another students' project is a swimming pool designed according to olympic specifications and constructed mainly by the students under Shramdan. A third project is an open air theater and parking

Indian Institute of Technology at Karagpur.

lot designed and constructed by the students. Each student spends an hour a day on Shramdan. Thus a total of 1,200 student hours of voluntary labor are spent every day at the University of Roorkee or about 200,000 man-hours per academic year. New and useful Shramdan projects are created by the fertile mind of Dr. Khosla, Vice Chancellor of the University, and are immediately put into effect by the student body under the supervision of the faculty.

Before leaving this subject of the student body, it is well to inquire what happens to the 95% of the applicants who are refused admission to a university because they failed to be among the top 5% of those who took the examination. Well, about 5% of these succeed in the examination for the diploma course. The remainder have no chance to become engineers. A few take examinations for less difficult vocations (clerks, stenographers, and white collar workers), others seek government service as policemen, soldiers, railway employees, postal employees, etc., and still others become tradesmen. Some are without jobs. It is this idle group of young men who are a great concern to the government and the community. One of the greatest problems which India faces today is to supply work to these idle young men.

The administration building of Roorkee University at Roorkee, India.

Curricula

Unlike American universities, Indian universities offer varying courses. For the undergraduate student, there are diploma courses and degree courses; and for the graduate student, there are refresher courses, and specialized courses leading to advanced degrees. Let us examine these courses in detail.

The diploma courses are intended to develop overseers, draftsmen and other non-professional men who are associated with engineers. The emphasis in these courses is less on the theory and more on the practical aspects of engineering. In Roorkee University, associated with electrical engineering, there are diploma courses in drafting, wiring, and the care and repair of electric machines. Each course lasts for two academic years, at the termination of which the successful student receives a diploma. Plans are under way to expand these courses to three years. Overseers are in great demand in India. Hence virtually all graduates are employed. A great deal could be done to improve the diploma courses through specialization. These courses would serve the needs of the country far better if their object were to turn out competent electricians, plumbers, mechanics, machine tool operators, tool and die makers, foundry men, carpenters, radio repair men, automobile mechanics, etc. Such tradesmen are extremely rare in India and their scarcity will retard materially the progress of India's industrialization.

It is my considered opinion that a thorough overhauling of these courses is absolutely essential if the needs of industrialized India are to be met. In the not too distant future India will find itself short of men who are thoroughly acquainted with modern tools and modern industrial techniques.

I should like to remark here that the Indians are extremely capable craftsmen. Their silk saris, their ivory and rosewood work, their inlays of ivory on wood or of silver on iron, their brass work, in fact all their handicrafts reveal their excellent ability to execute detail and their infinite patience. It should be easy to train Indians in modern technical processes. In fact there is every reason to expect that they have the talent and ability to become excellent tool and die makers and superior tradesmen.

The degree courses in the better technical schools require four years. There are some universities, including Roorkee, which grant an engineering degree after three years of study. Plans are underway, however, to expand the training period in those universities to four years and thus make the engineering course a four year course throughout India.

Refresher courses at Roorkee and other universities extend over periods of three months. The sequence in Roorkee is one period of three months in civil engineering followed by one period in electrical engineering, a period in civil engineering, and a period in mechanical engineering. Thus four refresher courses are offered each calendar year, two in civil and one each in electrical and mechanical engineering. The teachers in these courses are drawn from the faculty as well as from specialists outside the university. Each three months' period is divided into two independent periods of six weeks each and the student has the choice of staying six weeks or three months as his circumstances require. These courses constitute an extra service rendered by the university to the public. The experiment is new in India and deserves the support of the government and private industry.

The students of these courses come from government departments and private industry. Their tuition and expenses are paid by the employer. They are mature and experienced engineers. Their ages range from 30 to 50. I had the privilege of teaching two refresher courses during my two

years' stay in India and found the men eager, enthusiastic and hard working.

When I was at Roorkee there were no opportunities available for graduate study and research leading to the Ph.D. degree. The Vice Chancellor appointed a committee and assigned to it the task of drafting rules and regulations for the Ph.D. degree. This committee held several meetings and emerged with regulations similar to those of any first class American university.

The master's degree is awarded for one year's residence involving course work and a project which requires a moderate degree of original thought.

A new experiment in education was started at Roorkee University to implement one of the decisions of the Bandung Conference of the Asian-African countries: "In matters of technical aid, economic and cultural cooperation and exchange of experience, the countries of Asia and Africa will be reaching out to each other with the firm determination of benefitting by each other's experience on the basis of mutual cooperation viewed in the larger context of world cooperation." The Water Resources Development Training Center (W.R.D.T.C.) at Roorkee University is an institute of advanced study in water resources and their use for irrigation, flood control, navigation and electric power. Students who take this course must be graduate engineers with five years of engineering experience (officer engineers). The course covers such topics as river valley projects in India, Bhakra-Nangal Project, dams, mass concrete and its properties, concrete and masonry dams, laboratory aids to design, project investigation, treatment of foundations, flood control, design of power plants, earth dams, hydrology and dimensional analysis. The teachers for these topics are seasoned specialists invited by the university for periods varying from a few days to a few weeks or months to lecture on their specialties. Specialists selected from among the faculty of the University also participate in this program. Finally the University of Roorkee has the support of the Union Government of India which through the United States Technical Cooperation Mission and the International Cooperation Administration sends specialists for this purpose. Besides attending lectures, the students go on conducted tours to various dams, river valley projects, hydroelectric power plants, irrigation projects and other water resources development centers in which India abounds.

The presence of Dr. Khosla, a world authority on the development of water resources, as the Vice Chancellor and Director as well as guiding genius of this experiment has added great prestige to W.R.D.T.C. This experiment in higher education has far reaching possibilities and the University is sparing no effort to make it a success.

Faculty

Although the buildings and equipment in a university can be erected and installed within a short period of one or two years, time is required to educate the faculty. Hence, we find the unhappy situation in India of an excellent student body confronted by an inexperienced, poorly trained, and poorly paid faculty. This must not be construed as a reflection on all the members of all the faculties of Indian universities. In my contacts with various educational institutions, I have come across some of the most capable and most experienced teachers. Indeed some are brilliant, as witness Sir C. V. Raman, a Nobel Prize winner in physics. On the whole, however, the faculties are not as good as one would wish. The Government of India is alert to this problem. The Ministry of Education, during my last year in India, was studying the institution of a scholarship scheme whereby the Government would select a certain percentage of each graduating class for scholarship awards. The holders of these scholarships would then become graduate students–instructors–researchers in Indian universities. They would spend three years doing graduate work towards a master's degree, teaching under the guidance of a capable professor and doing research. After this period of training they are either assigned teaching posts in their field or allowed to pursue further graduate study, research and teaching for another period of three years at the end of which they are awarded the Ph.D. degree and assigned to a higher teaching post.

At the time I left India this plan had not been approved by the various ministries concerned. I feel certain, however, that it will be put into effect, much to the benefit of higher education in India.

Another plan consists of sending teachers or graduate students for study abroad in the United States, the United Kingdom, Germany, Belgium, France, the Netherlands, Switzerland, the Scandinavian countries and Russia. This plan has been in existence for the past decade. It is, however, less desirable than the first plan because of the cost involved. Thus the cost of five to ten scholarships under the first plan is equivalent to the cost of only one under the second plan. The cost, of course, depends upon the cost of education in the foreign country to which the teacher or graduate student is sent. The need is urgent and the demands on the budget of the government of India do not allow the luxury of sending many graduate students abroad.

A third plan is the "Participant Program" instituted by the government of the United States, whereby selected faculty members are given scholarships to various educational institutions in the United States for a full year's study with all expenses paid by the United States Government. This program suffers from the one year limitation and would be effective, although costly, if the Indian faculty member were allowed to remain until he gets his Ph.D. Another defect of the Participant Program is that it attempts to improve the knowledge of those already in the teaching profession rather than to create new teachers, which are really the more urgent need of India.

Fourthly there is the program of furnishing American teachers to Indian universities. This takes two forms: the Fulbright Program and

Continued on page 35

SUMMER ENGINEER

A CORNELLIAN ANALYZES AN INTERESTING AND PROFITABLE SUMMER IN INDUSTRY

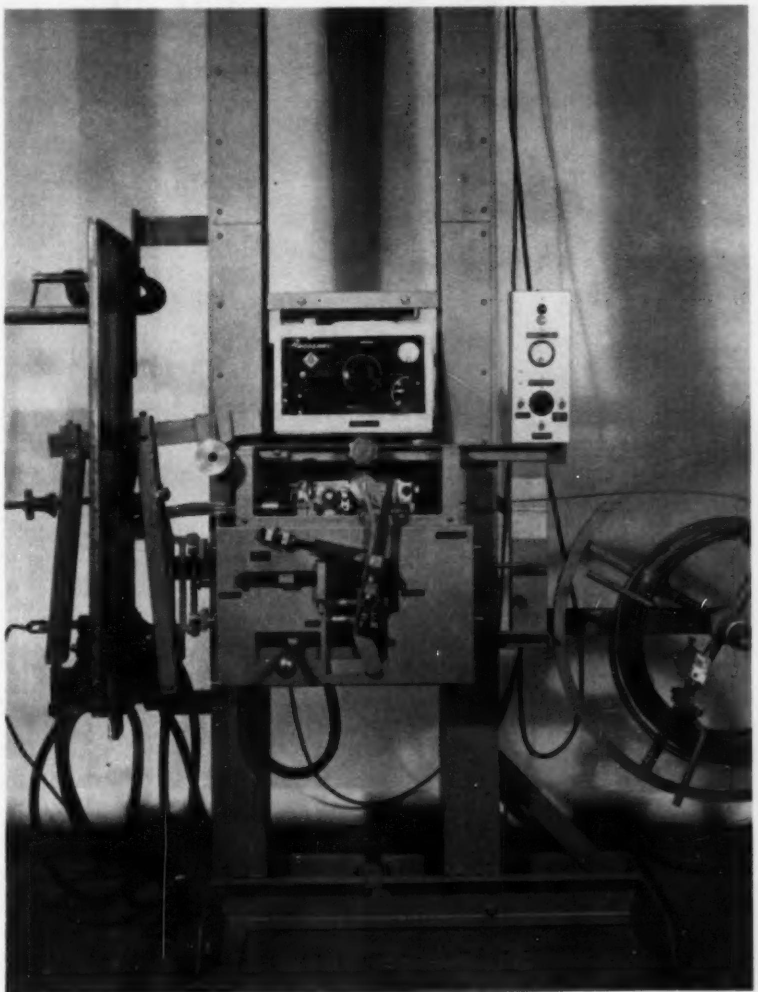
by Daniel D. Thomas, EE '64

The qualities of an engineer are no different from the qualities which make any man worth the elements of which he is made. An engineer should work tirelessly with regard given only to the result of his labor and not to the material benefits. It is never too soon to begin learning, and so, I offer my experiences as a "summer engineer" in the hope that others may profit from them. The physical results of my work are shown in the photographs and diagrams, but it is not the machine which is important, it is the building and planning which went into the final product which made my summer both enjoyable and well worthwhile.

Job Hunting

When I began my search at the end of the school year, I found out right away that the main problem for engineering students in finding a summer job that will contribute to the all-important job history which future employers are concerned with, seems to be educational limitations. Except in the co-op program and in a few unusual organizations, engineering concerns simply cannot make use of the dubious talents of freshman, sophomore, and in many cases, junior engineers. At more than one company this summer I was told: "Of course we hired fifty students this summer, but we also turned down over five hundred." The way is rough and may seem impassable in many cases, but the only advice I have ever been given that seems fitting is the word "persistence." I have been told many times that the student who starts early in the year, and keeps looking for a job will probably get one in the end.

Adult business connections help and need not be considered under-



Acros Corporation

Vertomatic G detail with one inch thick steel plates in place on the left. The flux-filled wire produced by Arcflux of Philadelphia feeds off the spool at the right while the arc length is controlled by the Arcosarc Magnawelder in the top center.

handed at all. In my case, it was my father who finally came up with the lead to Industrial Research Laboratory, in Philadelphia. Mr. René Colinet, the president, became my director, but in an organization the size of IRL, with only three, including myself, in the office and three men in the shop, there was no problem in communication between branches of the company. This free atmosphere is very desirable for summer work, because much time can be wasted in getting to know the operation of a very large company. On my first day I was at a desk with a set of drawing instruments and blueprints of a machine similar to the one we intended to design.

The Vertomatic G

Specifically, my assignment was to work with Mr. Colinet in redesigning a German vertical arc welding machine so that it could be produced in America at a price which would be competitive with similar machines on the market. In order to accomplish this, it was necessary to buy parts which were already produced in America. Whereas the Germans follow the European procedure of making everything from simple knobs to complicated items such as the welding shoes in their own plants, we were able, by careful design and planning, to cut our costs to about $2500 from the original German list price of $4500. Before going to specific designs, however, it was imperative that we understand all the functions of each element of the machine as well as the basic principles of its operation.

In the last few years, the need for an automatic machine producing vertical welds in steel plates of virtually any thickness over one-quarter inch has become more and more apparent. The best machine designed to meet these needs was the Vertomatic G built by Arcos Aachen in Germany. It welds steel plates over three-eighths of an inch thick and produces good welds in plates as much as two inches thick. The welding wire which contains the flux is fed by a motor which automatically controls the rate of feed and

produces a shielded arc of constant length. Oxidizing elements of the air are kept away from the weld by an atmosphere of carbon dioxide injected through a pair of copper shoes, one on either side of the joint between the plates. Because this joint must be completely filled with weld metal at a temperature hot enough to produce proper fusion with the parent metals, these water-cooled copper shoes are placed so as to hold the weld metal in place as it cools as well as giving the proper shape to the face of the weld. As the cavity between the plates is filled, the whole machine assembly rises at an adjustable rate. To produce proper fusion to the parent metal in very thick welds, an adjustable speed traverse motion is provided which moves the arc back and forth with respect to the work in a plane halfway between the butted plates and perpendicular to them.

We immediately saw, therefore, that the basic principles of the German Vertomatic G were indeed sound and that our main problem would be to find suitable American substitute parts. It was in this respect that I was given almost complete liberty in doing as much as I could in shopping for the parts and designing what brackets and fixtures we needed to hold them.

A Sophomore Engineer

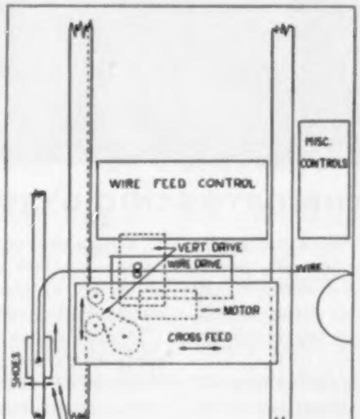
No one can say that a sophomore engineer with Cornell's background courses in machine tools and design drafting is of no value in operations such as I am about to describe. The most complicated and expensive items we made in the shop were the copper shoes. Their size is critical in forming the weld, and they must have provision for water cooling and injection of carbon dioxide. But the German design was adequate, so on the first day I was able to produce shop drawings of the shoes converted from metric to American sizes. A reference to the classified telephone directory gave me the names of several suppliers of pure copper, one of which could supply copper at the size and price we wanted. After a short stop-off on the way to work to pick up the copper, the shop men were ready to start work.

Estimating the Cost

In building a prototype of this sort, it must be remembered that labor costs are generally astronomical when compared to the cost of materials. It was the cost estimate which was, in fact, one of the most involved parts of the whole job. It was necessary to be as accurate as possible, so that our prospective customer, Arcos Corporation of Philadelphia, could give us a go-ahead on the project. To make a cost estimate, each shop operation is broken down into its parts as soon as all the components of the machine are designed. These costs are added to the cost of the raw materials and an overhead which included our salaries. Thus, with a prototype which is often being designed as it is built, an early cost estimation is indeed difficult.

A Few Problems in Design

Perhaps the hardest items to transpose from the German machine were the traverse and vertical drive motors. Because the notations on the German drawings were beautiful in their artistic statement but deceptive in their ambiguity, Mr. Colinet and I made several trips to leading electrical suppliers and wrote several letters to Germany before we could determine and buy the equivalent American motors.



D. D. Thomas

Schematic diagram of the Vertomatic G which the author helped redesign during the summer. An example of engineering ingenuity is shown by vertical drive arrangement. The motor drives a variable-speed pully which engages a clutch. The German clutch was replaced by an inexpensive American motorcycle clutch to permit quick, accurate control of the unit's vertical position.

The mechanism which took the greatest amount of our time was the traverse system. Here, prototype engineering showed its value as a trainer of patience, for the engineer must be willing to completely scrap a set of parts at any time, if the product is to be of a caliber worth marketing. In the case of the traverse mechanism it was not until the whole system was fully completed and in operation that we realized that the motion was not smooth, and the change of direction too noisy. So we hung the cost, threw the whole system out, and designed another! The present mechanism, which has a patent pending, relies on a heart-shaped cam to provide both a traverse and change-direction feature combined with a separate adjustable dwell at the end of each passage to make the arc pause and heat the parent metal properly.

Final Assembly and Testing

As the shop produced the parts and the motors and other items arrived from outside, it fell upon Mr. Colinet and me to assemble the machine according to the assembly working drawings I had done earlier in the summer. As the machine took shape we made a few minor adjustments, added guards to hide unsightly gearings, and removed adjustments that appeared unnecessary. And so, after three months of the concentrated effort of six men, we had a machine ready for its final tests.

I have returned to Cornell, but the testing continues as this article is being prepared. Tests *will* continue, for it is not the job of an engineer to design, market and then forget his product. The Vertomatic G is on the market, and I will see it as its influence is felt in the welding industry. Here, then, is the real joy of engineering: to sit back and watch one's own efforts put to use. Those of us who have chosen engineering have pledged ourselves to a purpose. I believe I made my choice last summer.

Sir Isaac Newton

THE DEVELOPMENT OF NEWTONIAN MECHANICS

by Richard N. Karnes, CE '62

Every body continues in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed upon it.

The change of motion is proportional to the motive force impressed; and is made in the direction of the right line in which that force is impressed.

To every action there is always opposed an equal reaction; or, the mutual actions of two bodies upon each other are always equal, and directed to contrary parts.

– Sir Isaac Newton, 1686

The science of mechanics did not arise suddenly during the Renaissance, but had been gradually and spasmodically developing for a period of about two thousand years. Newton's discoveries and accomplishments are in a sense the grand result of all previous work in the field of mechanics. Even as this is written, Newton's theories, although still standard in the practical world, have been largely modified by the work of such people as Einstein. We begin the story of this development by examining the theories of the philosophers of ancient Greece.

The mechanistic method began with Leucippus, who conceived the atomic theory, and Democritus, who developed it. Democritus postulated that matter is made up of an indefinitely large number of individual "atoms" which differ only in size, position, and motion. To account for falling objects, Democritus claimed also that all atoms exhibit a "primordial" motion toward the center of the earth. Interestingly enough, he also said that atoms show a sort of sideways slip, causing impacts between neighboring atoms and exerting pressure upon the bounds of their volume. This was a marvelous guess, considering that this is exactly the same line of reasoning used in modern times to derive the ideal gas law. In fact, the later disciples of Democritus called the theory the "expression of the laws of chance impacts."

However, Democritus could not explain the mystical power which made a group of atoms act as a unit. Instead, he said that men's souls were but atoms of finer size and more agile motion, thus indirectly indicating that atoms themselves have the power of choice and purpose.

Astronomy

Modern astronomy may be said to have begun with Aristotle, for it is he who gave astronomy both its impetus and its ultimate stagnation in the Middle Ages. Aristotle formulated a universe in which the earth was the stationary center and the planets and sun revolved around the earth on concentric shells. The stars were all suspended on the second outermost shell, and the outer shell was the "Prime Mover" which controlled all the movements of the other shells and which was supposed to have a soul.

Ptolemy, another ancient, was puzzled by the discrepancies between Aristotle's theory and actual observation. Aristotle's planets all moved uniformly in circular paths, but in reality only the sun and the moon did so. The other planets moved erratically, first moving uniformly and then slowing down for a while. Ptolemy solved this problem with the invention of the epicycle, or the locus of a point on a small circle rolling on a larger circle. This ingenious system was very accurate, and similar methods must still be used today to calculate the positions of the heavenly bodies relative to the earth.

The Birth of Modern Mechanics

With the downfall of the ancient world also came the downfall of science, and in the Middle Ages the Church rose as the dominant power. The Church filled all the needs of the people and took over all three phases of leadership – religious, educational, and governmental. Therefore the Church met no resistance in its denunciation of atomic theory and Ptolemy's mechanistic universe, and these achievements fell into oblivion. It is interesting to note the Church's objection: Belief in a mechanistic order violates the idea that the soul is supreme. Louis Trenchard More[1] sums up this attitude very neatly: "There can be no doubt that the logical conclusion of [atomic theory and a mechanistic universe] is a denial of every form of free will; and in that sense it is atheistic."

The Church clung closely to the Aristotelian theory, maintaining that the "Prime Mover" was God himself. By the time of the Renais-

sance the sum total of mechanical theory was that all phenomena were due to the postion and motion of a universal substance (ether) which has an existence unaffected by man's perceptions. The downfall of this line of reasoning was the following question: How can an inert substance create in our minds the complex perceptions which are received from the external world? A limited but rising sentiment grew against Aristotelian science, and the Ptolemaic theory was disliked because of its increasing complexity with the discovery of more and more variations in the orbits of the planets.

Copernicus (c. 1510), a great scientist, philosopher, and educator, meditated on the insufficiencies of Greek astronomy. He believed there was simplicity and order in nature, and yet Aristotle failed to account for the eccentricities of the planetary orbits. He also puzzled over the hypothesis that the stars all revolved at the same rate about the earth. Astronomers now had some idea of the distance to the stars, which led to the conclusion that they were whirling through the universe at unbelievably rapid speeds.

While doing research in ancient astronomy, Copernicus found the following passage: "Heracles of Ponta and Ecphantus, the Pythagorean, make the earth move, not however in the movement of translation, but in a revolving movement, like a wheel on its axle revolving about its own centre from the west to the east." This, then, was the answer to the movement of the stars: the earth rotated on an axis. Upon further thought, Copernicus realized that the circular motion of the planets would be a reality if the sun were the center of the universe rather than the earth.

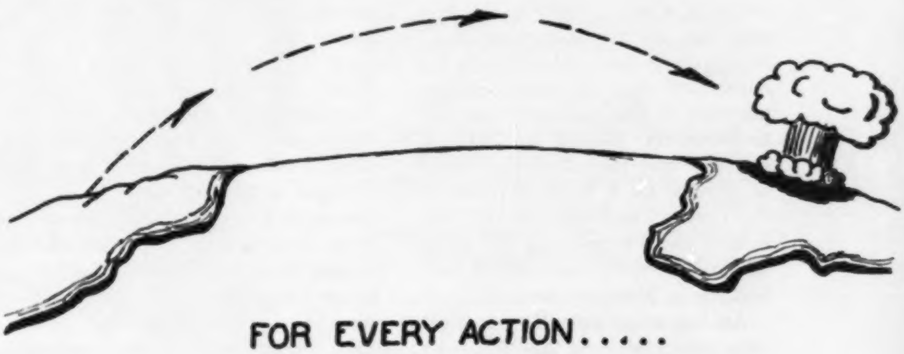
Copernicus realized that his theory would encounter fierce opposition from the Church, and that the average man-in-the-street would be terrified at the suggestion that the earth was in fact whirling at rather high speeds through space. The Aristotelians would also cry out, since the theory would cause the crumbling of all of Aristotelian philosophy. With misgivings, Copernicus published his theory in the year of his death, and was thus the first man in comparatively recent times to openly refute Aristotle.

Johann Kepler was impressed by the work of Copernicus, and, in his naive youth, staunchly offered a theory that the planetary orbits were actually inscribed and circumscribed circles of the five regular polyhedrons. However, after countless observations, he was forced to abandon this theory. His research finally led to three empirical laws: 1.) Planetary orbits are ellipses with the sun at one focus; 2.) Areas swept by a line from the sun to a planet in equal times are of equal area; 3.) The cube of the mean distance of a planet from the sun is proportional to the square of its period of revolution. Thus, in this last law, Kepler finally developed the simple law he was looking for in astronomy.

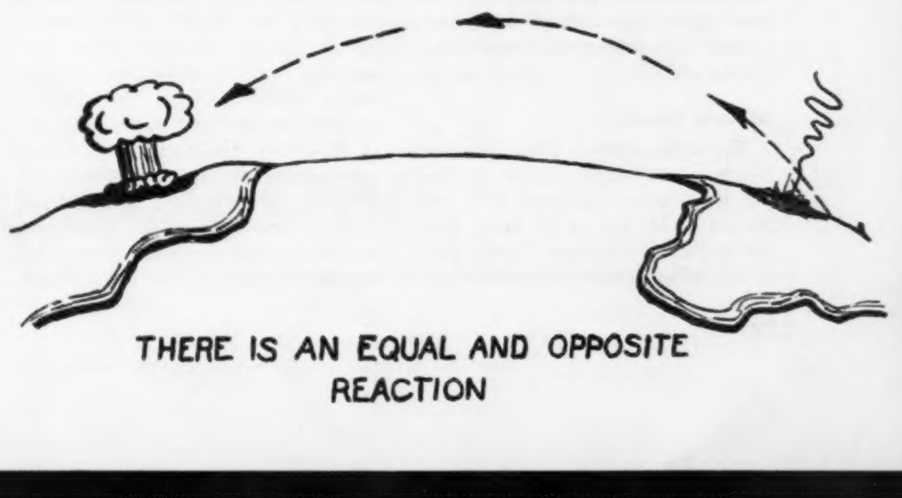
Interestingly, the discoveries of both Copernicus and Kepler hinged on the principle that nature always adopts the simplest and most symmetrical course, which is *not* necessarily true. Also, Kepler left a very puzzling question: Why do the planets follow elliptical orbits?

Now let us descend back to earth and look at Galileo. Although Galileo gave modern astronomy its greatest contribution – the telescope – his main field was falling bodies. He was the first to show that the speed of a falling body is constant, regardless of its weight. Witnesses to his experiments agreed that all his falling objects *appeared* to land at the same time, but that it must have been an optical illusion, since Aristotle said that different weights fall with different velocities. This led to a hot controversy with the Church's Aristotelian views, and Galileo's further discoveries heaped more coal on the fire, particularly the non-Aristotelian discovery that projectiles do not move in a straight line and then fall vertically to earth, but that they move in a parabolic arc.

Galileo's last book (Dialogh Delle Nuove Scienze) laid the groundwork for Newton's discoveries. Especially notable is his work leading up to Newton's three laws. Although the prevailing view was that force is proportional to velocity, Galileo said that force was proportional merely to the *change* in velocity of a body, which he



FOR EVERY ACTION.....



THERE IS AN EQUAL AND OPPOSITE REACTION

Richard Karnes

proved with balls and inclined planes. He also proved that a freely falling body is equivalent to a ball rolling down an inclined plane of ninety degrees. He also said that velocity is constant if all accelerations and retardations are eliminated, but his immediate application of this principle was only to horizontal planes. In addition, he said that the downward force of gravity on a body is equal to the upward resistance of the horizontal plane supporting the body. These principles are clearly embodied in Newton's laws.

An important corrollary to Galileo's principles was that if a body moves uniformly in an arc, there can be no force along the arc of the circle; therefore, all force must be directed at right angles to the line of motion. This led to Huygens' law of centrifugal force and to Newton's ultimate solution of elliptical orbits.

Sir Isaac Newton

The apple story is true! One day Newton was sitting under an apple tree, when an apple fell, not on his head, but at his feet. This set his mind clicking. If the pull of the earth could reach to the apple in the tree or to a mountain top or to a bird in flight, why could it not reach the moon? He supposed that if a stone were transported to the height of the moon and let fall, it would fall back to earth just as did the apple. Then, if the moon were stopped from revolving around the earth, it ought also to fall to earth with the same rate as the stone. He then thought of himself standing on a mountain top. Suppose he threw a stone in a horizontal direction. It would land below and some distance away from him. Now suppose he could throw the stone hard enough that it went beyond the horizon. Then, as it fell, it would fall beyond the earth. It would keep falling and continue to go beyond the earth; in effect it would become a satellite, just as the moon is a satellite of the earth. Newton then concluded that the moon is nothing more than a projectile, alway falling, but always passing beyond the earth because of its speed. He decided that the moon would follow an elliptical orbit if the gravitational force acting upon it just equaled the centripetal force exerted on the moon by the earth. With the use of Galileo's laws he devised his famous equation of gravitation

$$F = \frac{Kmm'}{R^2}.$$

Thus, Newton succeeded in combining astronomy with Galilean mechanics. In addition, he also combined these with Democritus' atomic theory, in that his laws of mechanics and gravitation applied to particles or bodies of any size whatever.

Newton extended Galileo's principles to include any body, thus giving birth to his perfectly general Three Laws, which made exact quantitative mechanics a reality. He also reasoned that if the earth's gravitation extended to the moon, then it must also extend further and indefinitely into space. Also, since his laws were of a general nature, all bodies must exhibit gravity. From this conclusion he hit upon the explanation of elliptical orbits: They are the resultant of the rectilinear motion of the planet and the centripetal force exerted on the planet by the sun.

In summary, Newton 1.) generalized the idea of force. His laws deal only with position and motion, and are thus readily expressed mathematically; 2.) stated that the universal property of all bodies is mass, which is independent of force, for a body at rest exerting no force still has mass; 3.) gave us the parallelogram of forces, e. g., two or more motions can act simultaneously and independently on a body; 4.) devised the law of action and reaction, without which space flight could never have been possible.

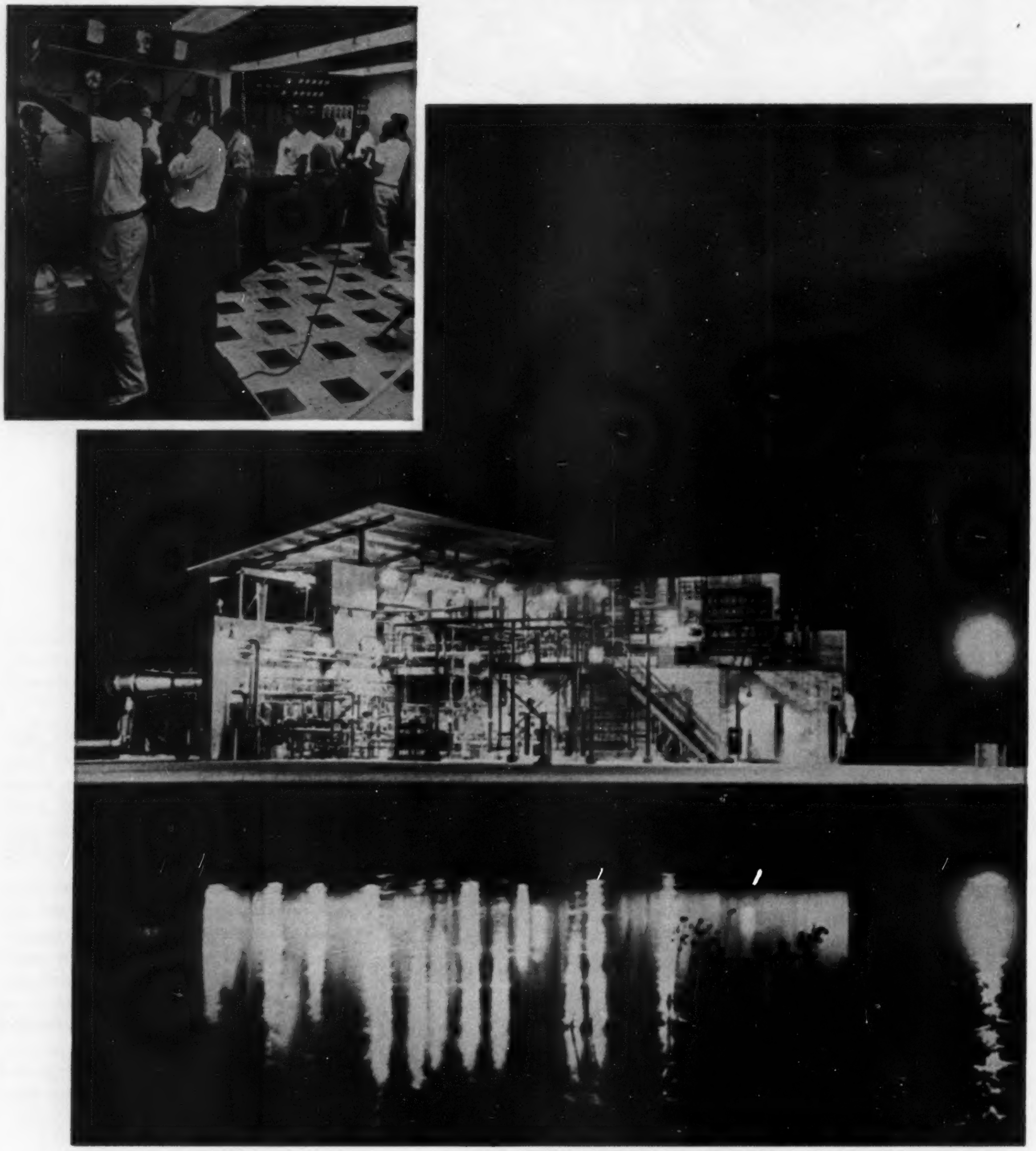
To Newton we must ascribe the honor of creating order out of chaos. Using only the guesses of his predecessors he gave us an almost perfect mechanical theory. Unknowingly, Newton also laid the foundation for Einstein's Theory of Relativity some two hundred years later:

The motions of bodies included in a given space are the same among themselves, whether that space is at rest or moves uniformly forward in a straight line.
Sir Isaac Newton, 1687

FOOTNOTE

[1] *Isaac Newton, a Biography*, p. 256 Louis Trenchard More. 1934.

What would *YOU* do as an engineer at



Development testing of liquid hydrogen-fueled rockets is carried out in specially built test stands like this at Pratt & Whitney Aircraft's Florida Research and Development Center. Every phase of an experimental engine test may be controlled by engineers from a remote blockhouse (inset), with closed-circuit television providing a means for visual observation.

Pratt & Whitney Aircraft?

Regardless of your specialty, you would work in a favorable engineering atmosphere.

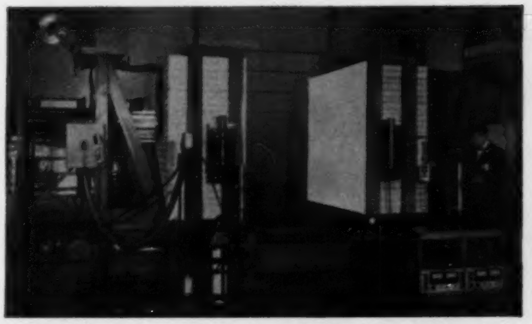
Back in 1925, when Pratt & Whitney Aircraft was designing and developing the first of its family of history-making powerplants, an attitude was born—a recognition that *engineering excellence* was the key to success.

That attitude, that recognition of the prime importance of technical superiority is still predominant at P&WA today.

The field, of course, is broader now, the challenge greater. No longer are the company's requirements confined to graduates with degrees in mechanical and aeronautical engineering. Pratt & Whitney Aircraft today is concerned with the development of all forms of flight propulsion systems for the aerospace medium—air breathing, rocket, nuclear and other advanced types. Some are entirely new in concept. To carry out analytical, design, experimental or materials engineering assignments, men with degrees in mechanical, aeronautical, electrical, chemical and nuclear engineering are needed, along with those holding degrees in physics, chemistry and metallurgy.

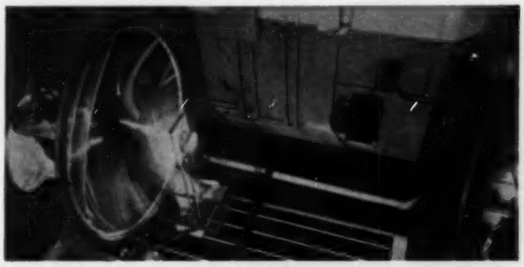
Specifically, what would *you* do?—*your own engineering talent* provides the best answer. And Pratt & Whitney Aircraft provides the atmosphere in which that talent can flourish.

For further information regarding an engineering career at Pratt & Whitney Aircraft, consult your college placement officer or write to Mr. R. P. Azinger, Engineering Department, Pratt & Whitney Aircraft, East Hartford 8, Connecticut.



At P&WA's Connecticut Aircraft Nuclear Engine Laboratory (CANEL) many technical talents are focused on the development of nuclear propulsion systems for future air and space vehicles. With this live mock-up of a reactor, nuclear scientists and engineers can determine critical mass, material reactivity coefficients, control effectiveness and other reactor parameters.

Representative of electronic aids functioning for P&WA engineers is this on-site data recording center which can provide automatically recorded and computed data simultaneously with the testing of an engine. This equipment is capable of recording 1,200 different values per second.



Studies of solar energy collection and liquid and vapor power cycles typify P&WA's research in advanced space auxiliary power systems. Analytical and Experimental Engineers work together in such programs to establish and test basic concepts.

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New home for Department of Metallurgical Engineering . . .

BARD HALL

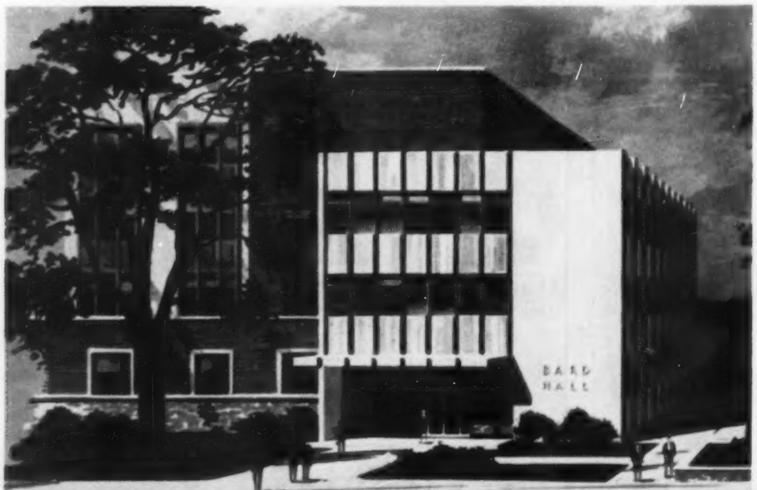
by Jeremy Shapiro, ME '62

Bard Hall is the latest prospective addition to Cornell's ever-growing engineering quadrangle. When completed, the $1,500,000 structure to be erected between Thurston and Hollister Halls will house completely the metallurgical engineering department of the School of Chemical Engineering. At present, the plans are in the process of being completed by the architect, and bids will be taken early next year, after which the ground will be broken for actual construction next spring. It is hoped that the building will be completed by the fall of 1962.

The new hall is the gift of Francis Norwood Bard, ME '04, an Illinois industrialist in the metallurgical field, who has had an active interest in the metallurgical engineering program ever since its inception in 1947 when he established a chair for that course of study. At the present time, there are 52 undergraduate and 12 graduate students enrolled in the program headed by Professor George V. Smith.

Growth of Interest in Metallurgical Engineering

In recent years, there has been a marked growth of interest in the science of metallurgy and metallurgical engineering due to an increasing awareness on the part of engineers in many fields that the materials involved in an engineering project are often its limiting factors, or bottlenecks. A notable example of this phenomenon is found in the field of rocketry where there has been a great lack of materials capable of withstanding the high temperatures caused by the friction of our atmosphere on the rockets at high speeds. Another example is found in the field of power generation where the sole limiting factor in the efficiency of steam turbines is the maximum temperature to which the materials can be subjected. And with the development of nuclear power plants, new materials to withstand still higher temperatures are needed.



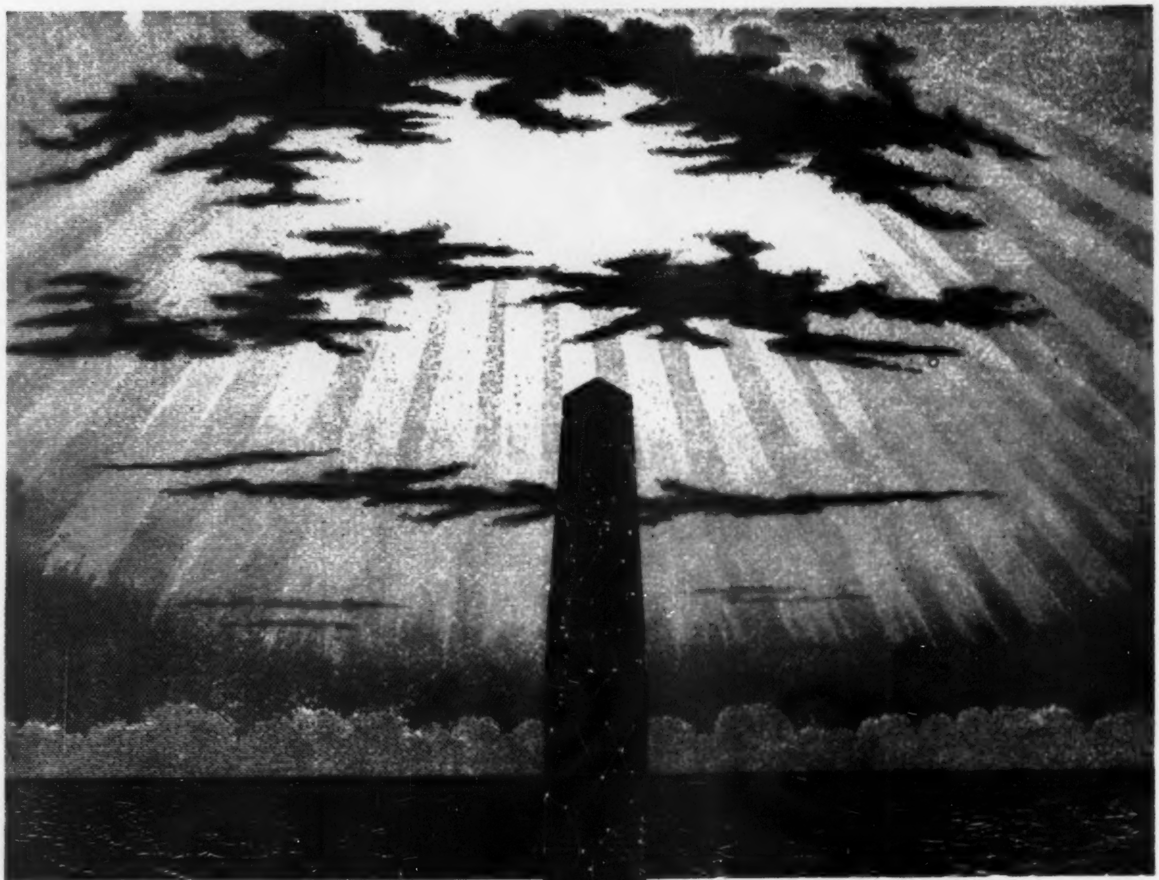
An artist's sketch of Bard Hall.

The Scope of Metallurgical Engineering

In general, metallurgical engineering can be divided into two broad fields. First, there is the one in which the engineer concerns himself with the problems of extracting metals from their ores. This field is close to chemical engineering in that chemical reactions describe the important processes that take place. However, the reactions in question here occur at temperatures much higher than those encountered in ordinary chemistry. The second field is that of the processing, alloying, and heat treatment of metals after they are extracted from the ores.

Graduates of the metallurgical engineering program find job opportunities not only with the companies actually involved in the extraction and processing of metals, but also with purchasers of these metals. The automotive, aircraft, and power generation industries, among others, all have a definite need for young men trained in this subject.

Bard Hall is another manifestation of the amazing progress of engineering science in America in the years since World War Two; and at Cornell, the progress has been just as remarkable. In this short length of time, a whole new course of study has been programmed, initiated, and now has become sufficiently important to deserve and need its own facilities. Perhaps one day metallurgical engineering will become a separate school of the Cornell University College of Engineering.



The care and feeding of a missile system

It takes more than pressing a button to send a giant rocket on its way. Actually, almost as many man-hours go into the design and construction of the support equipment as into the missile itself. A leading factor in the reliability of Douglas missile systems is the company's practice of including all the necessary ground handling units, plus detailed procedures for system utilization and crew training. This complete job allows Douglas missiles like THOR, Nike HERCULES, Nike AJAX and others to move quickly from test to operational status and perform with outstanding dependability. Douglas is seeking qualified engineers and scientists for the design of missiles, space systems and their supporting equipment. Write to C. C. LaVene, Box B-600, Douglas Aircraft Company, Santa Monica, California.

Alfred J. Carah, Chief Design Engineer, discusses the ground installation requirements for a series of THOR-boosted space probes with Donald W. Douglas, Jr., President of DOUGLAS

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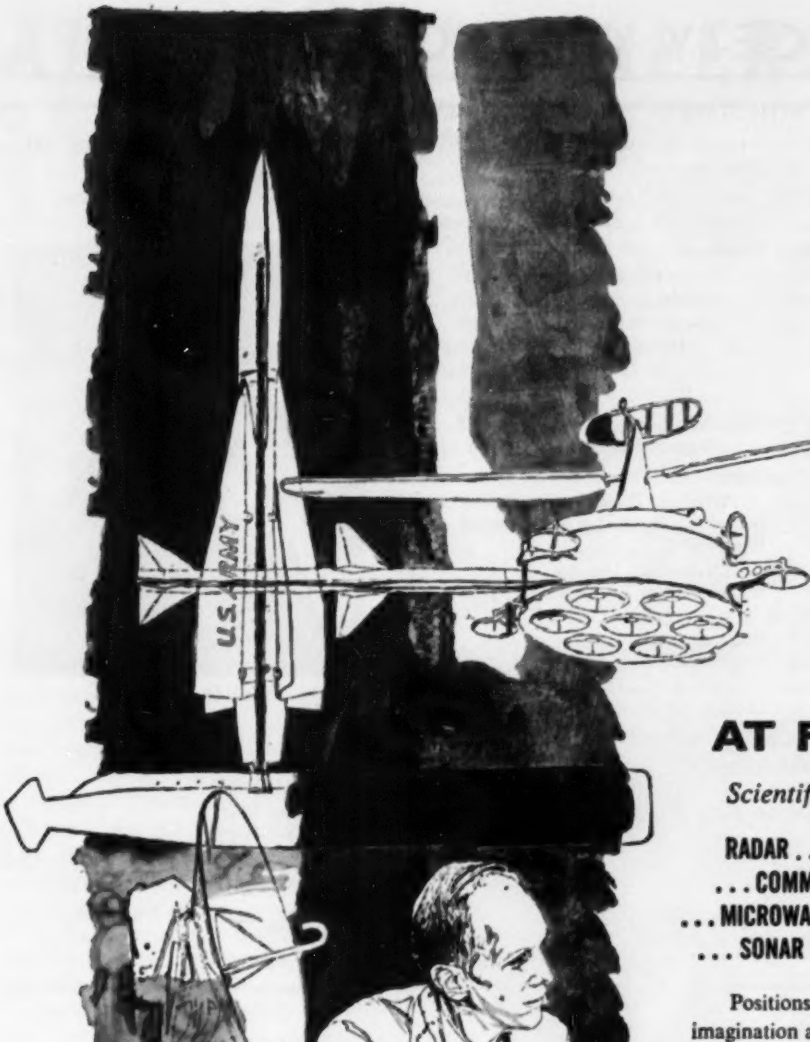
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"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students, and to establish closer relationships between the College and its alumni."

THE PRESIDENT'S LETTER—

December was a rather quiet month in the affairs of the Society. There were no regular meetings scheduled but plans were developed for February activities. I visited Chicago and had lunch with John Gnaedinger and some of his fellow officers. The January meeting that they had scheduled has been postponed to February due to illness of the scheduled speaker.

The plans for the February 1 meeting in New York are now firmed up. The meeting will be at the Engineers' Club, 32 West 40th Street, New York City, starting at 5:30 P.M. The speaker will be Harold S. Black of the Bell Telephone Laboratories, and his topic will be "Global Communications Via Artificial Earth Satellites." I hope all of the Society members attending the A.I.E.E. Annual Meeting will find time to join us and renew acquaintances with your fellow engineers.

Walter Hickey tells me that the next meeting scheduled for Boston will be their Annual Meeting in April at which time officers will be elected for the coming year.

Among the items of interest during the month of December was the Annual Award Dinner sponsored jointly by the Cornell Alumni Association of New York City and the Cornell Club of New York which was attended by a goodly number of Engineers. The Awards for 1960 went to John M. Olin, B.Chem. '13 and Spencer T. Olin, M.E. '21. Each is a member of the Board of Trustees of the University and has contributed substantially, both in substance and talents, to furthering the interests of the University. Hollister Hall, the new Civil Engineering building was the gift of Spencer Olin. Incidentally, Olin Hall, the Chemical and Metallurgical Engineering Building was the gift of their father, Franklin W. Olin '86.

Our membership is continuing to grow and now includes 122 members from the Class of 1960.

PAUL O. GUNSALUS

ALUMNI ENGINEERS

Dr. James E. Storer, B.Physics '47, has recently been promoted to the newly created position of senior scientist at Sylvania Electric Products Inc., a subsidiary of General Telephone and Electronics Corporation.

Dr. Leonard Sheingold, director of the applied research laboratory said that the appointment was in recognition of "outstanding scientific contributions" in an atmosphere "conducive to create research."

The Applied Research Laboratory is a facility of Sylvania Electronic Systems, a major division of the company. The laboratory's research projects primarily involve the general field of information processing. Fundamental and applied research there have led to advances in new and advanced communication systems, radio and plasma physics, applied mathematics and circuit analysis.

Prior to joining Sylvania in August, 1957, Dr. Storer served as a consultant to the Applied Research Laboratory, performing studies relating to military systems analysis. His subsequent work at the laboratory has included fundamental research in signal analysis and data processing. He has investigated novel digital codes for radar and communications using advanced mathematical techniques. Dr. Storer's major contribution has been the synthesis and analysis of new types of digital data communication systems.

Born in Buffalo, N. Y., Dr. Storer received a bachelor's degree in physics from Cornell, and master's and doctor's degrees in applied physics from Harvard University. He has been an Atomic Energy Commission fellow, a research fellow and lecturer at Harvard, and a John Simon Guggenheim fellow. During his tenure as assistant professor in the division of applied science at Harvard, he served as consultant to Sylvania and other companies.

Author of numerous technical papers, Dr. Storer has also written a book, "Passive Network Synthesis." He is a member of Sigma Xi, the American Association of Physics Teachers, the American Institute of Physics and the Institute of Radio Engineers. Dr. and Mrs. Storer and their three children reside in Lexington, Mass.

Bryce I. MacDonald, Jr., B. Chem.E. '45 has been named manager of manufacturing engineering at the Silicone Products Department of the General Electric Company, Waterford, New York. He succeeds Dr. E. M. Koeritz who recently took up a new post as manager of manufacturing at G-E's Metallurgical Products Department, Detroit, Michigan.

Alumni News

Bryce I. MacDonald, Jr.

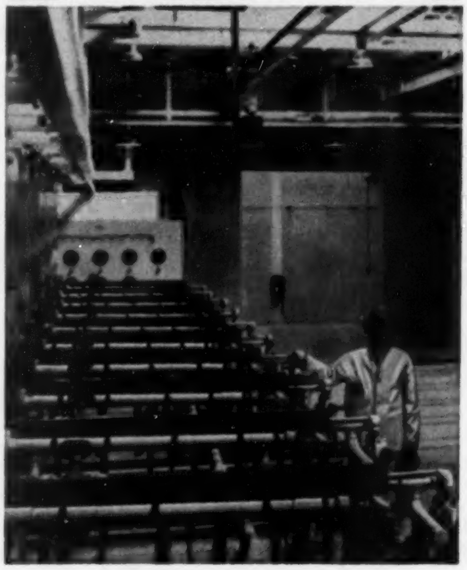
In his new post, MacDonald will have combined responsibility for manufacturing engineering and facilities engineering at the plant, which is the headquarters for manufacturing, research and sales for General Electric silicones.

A native of Wilmington, Delaware, MacDonald graduated from Cornell University in 1945 with a degree of Bachelor of Chemical Engineering. He joined General Electric in 1946 and held various process and project engineering assignments until 1951 when he became supervisor of process engineering at the Company's Silicone Products Department in Waterford. He entered facilities planning with the Silicone Products Department in 1956 and in 1959 became manager of facilities engineering, a post which he held until his present assignment. MacDonald is a member of the American Institute of Chemical Engineers.

Albert Deermont, C.E. '09, president of the construction firm of Coggin & Deermont, was named citizen of 1960 by the Kiwanis Club of Chipley, Florida. He was honored at a civic dinner highlighted by Cornell colors and music. He has served as mayor of Chipley, president of its Kiwanis Club, and president of the Florida Road Building Association. Mr. Deermont has personally planned many of Chipley's streets and also the town's sewer system. He was instrumental in obtaining a county hospital and became the first chairman of its board of trustees.

Richard R. Lyman, M.C.E. '03, is still active as a consulting engineer. He has done consulting work on three of the seven modern wonders of the world as designated by the American Society of Civil Engineers: the Chicago, Ill., sewage disposal system, which serves fifty cities; the Colorado River aqueduct, which is the largest man-made conduit in the world; and Grand Coulee Dam and irrigation project. He is the inventor of the Lyman street numbering system, which revolutionized city planning technique in the Western States. Lyman also organized the school of mines and engineering at the University of Utah and taught there twenty-six years. He now lives in Salt Lake City, Utah.

Charles A. Perelli, B.S.M.E. '44, after eight years as a project engineer with Wigton-Abbot Corp., industrial & chemical division, in Newark, New Jersey, has become a project engineer with the Leemus Co., refinery and chemical engineers and constructors. His new position was obtained through the University Placement Service. He now lives in Madison, New Jersey.



Facts about chemical job assignments that can influence your future career

Do you know the number of different kinds of jobs in the chemical business? It's one of the biggest factors favoring a career in chemistry! Chemists and chemical engineers may find their spots in research, development, analysis, testing, production, technical service, management, or sales.

Nowhere is this more true than at Allied Chemical, maker of more than 3,000 diversified products—chemicals, plastics, fibers and building materials—in over 100 plants throughout the country. And Allied makes every effort to see that new employees find the kind of work that matches their talents . . . that suits them best and interests them most.

Ask our interviewer about career opportunities at Allied when he next visits your campus. Your placement office can give you the date and supply you with a copy of "Your Future in Allied Chemical." Allied Chemical Corporation, Dept. 161-R3, 61 Broadway, New York 6, N. Y.

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TECHNICAL EDUCATION . . .

Con't from p. 16

the I.C.A. Program. Under the provisions of the Fulbright Act, monies due the United States, from the sale of surplus equipment after World War II, are retained by the foreign government and used to pay salaries and expenses of American professors who go to India. Under the I.C.A. Program a contract is entered into between I.C.A. Washington and an American university to supply faculty members to a selected group of Indian universities. These American educators go to India for varying periods of six months to two years and help the Indian university to which they are assigned, in teaching, doing research, guiding graduate work or organizing laboratory facilities, curricula etc. I believe that the United States is rendering a very much needed service to India in sending its educators to perform such tasks. I also believe that American educators who go to India under this program are ambassadors of good will and contribute to the understanding between these two great nations. The cost of this program is very small indeed compared with the good will it creates and, from my own experience, I suport it wholeheartedly.

Russia is sending help to India along lines similar to those of I.C.A. Washington; the British Commonwealth also sends educators to India under the Columbo Plan. Finally the U. N. has a mission in India, one of whose objects is to aid in India's educational problems.

Thus, India is fully cognizant of the problem of staffing its new universities and technical institutes, and raising its standard of technical education. The government of India is doing its utmost to solve this problem alone when it can and with the help of friendly nations when this help is needed and requested.

Equipment and Libraries

Equipment is a necessary part of all technical education. It is needed for both undergraduate and graduate study. The laboratories for undergraduate teaching are, on the whole, adequate, although improvement is necessary in most cases. The equipment for graduate work is almost non-existent and its procurement from foreign countries involves delays and red-tape which are hard for us even to visualize. I.C.A. Washington realizes this situation. Hence, it invariably includes, in its contracts with American educational institutions, provisions for the purchase, in the United States, of equipment which the American teacher deems necessary to carry on his duties in India. Our government has also entered into an agreement with the Indian government to allow all such equipment to enter India duty free. Through these provisions many Indian technical institutions and universities have received much needed American equipment for both undergraduate and graduate instruction. The need is, however, extremely great and the governments of India (both State and Union) have supplied much of the equipment through appropriations to technical education. In this connection may I here state that the Indians are a very proud people. They appreciate the help they are receiving from the United States and other foreign governments but they do not seek handouts. Indeed they look at the problem just as we do, of cooperation among peoples and nations for a better, happier and more peaceful world. This is why they like the names of Technical *Cooperation* Mission (T.C.M.) which is the representative in India of the International *Cooperation* Administration (I.C.A.). This matter can not be overstressed. It is the cornerstone of success in our relations with India and should be the watchword of every American who accepts a foreign assignment. India is indeed ready and willing to cooperate with other nations under similar conditions. The Water Resources Development Training Center (W.R.D.T.C.) is one instance of such cooperation.

Just as essential as equipment are good technical libraries. Books in India are extremely expensive. There are very few technical books written by Indian authors and published in India. Hence most technical books are imported either from the United States or from the United Kingdom. An eight dollar book in the United States is worth Rs 40 in India. It does not take many books to exhaust library appropriations. No student can afford to buy books at such fabulous prices. McGraw Hill Book Company has found one solution to this problem. They have had some of their more popular books reproduced in Japan at a cost equal to about one third the cost here. These books are distributed throughout the Far East and have done much to lighten the financial load of students and university libraries. Most libraries, however, need books and back volumes of technical magazines such as the A.I.E.E. *Transactions*, *Electric Journal*, the *Electrical World*, the *Proceedings* of the British Institution of Electrical Engineers and the *Bell Technical Journal* to mention only a few publications in the field of electrical engineering. If anyone reading this paper wishes to contribute his library to an Indian university, I shall be glad to see to it that the books are packed in his home and shipped to that university at no cost to the donor and with as little inconvenience to him as possible.

Because of the scarcity and dearness of technical books, a very effective method of helping technical education in India is for the foreign teacher to write books or pamphlets in his specialty and have these reproduced in mimeographed form for the use of his and other students in India. I have no knowledge to what extent this is done in India. I did act on this idea and caused to be published by Roorkee University and other universities the following series of lectures:

a. Electric circuit analysis, based on my book *Electric Circuit Analysis* (mimeographed).
b. Refresher course lectures on symmetrical components and fault currents as well as on transmission lines (mimeographed).
c. Dimensional analysis (mimeographed).
d. Electrical machine design (mimeographed).

e. Magnetic and dielectric circuits (mimeographed).

f. The Rangue-Hilsch Tube published in the 1956 issue of the Roorkee University Annual Magazine.

g. Fourier series (mimeographed).

h. Symmetrical components and fault currents (published by the *Indian Construction News*).

i. Laplace transforms (mimeographed).

Cost of Technical Education

Education is extremely cheap in India, as compared with the United States. Most educational institutions are supported by the State and Union Governments. In this case they resemble our state universities. The tuition and fees are about Rs. 150 ($30) annually. The student spends about Rs. 1275 ($255) per academic year. This is about 10% of the annual educational expense of an American student. The writer has no estimates on the average income of parents who send their sons to the universities in India. A fair guess, however, would be between Rs. 300 and Rs. 400 per month. Thus it takes three or four months' salary to pay the expense of a child in a university. What makes matters worse is that there exist no opportunities for self help. Menial labor is shunned by Indian students and there is little likelihood that the American system of student self-help will ever be popular in India. It would therefore appear that the only method of solving the economic problems of Indian students is through loan funds and scholarship grants. The need for student help is so great that the Vice Chancellor of Roorkee University started a successful campaign among faculty, alumni and others to establish a student loan fund which could be used by the University to relieve temporarily the financial needs of some highly deserving students, who, through death of a parent or some financial reverses, can not continue their education without assistance.

Here is an opportunity for the Ford Foundation, which is doing excellent work in India, or some other philanthropic organization, to lend a helping hand not only in Roorkee University but also in other universities of India. I would suggest that the donor match such student aid funds rupee for rupee that the universities are able to collect from their alumni and friends.

Opportunities for Employment

India has the anomaly of industrializing rapidly, graduating an increasing number of engineers and yet being unable to offer employment to all its engineering graduates. Generally all civil engineers ultimately find jobs. This is not the case with mechanical and electrical engineers. This situation is unbelievable but it is true. A complete analysis of this problem is beyond the scope of this paper. Suffice it here to say that because the greater proportion of Indian industry is owned and controlled by the government, red tape is inevitable. This results in a lag of several months between the time a student graduates and the time he is employed. Thus there always exists a group of unemployed engineers among the recent graduates. A second factor is that private industry is loath to invest money in a program of training cadet engineers. Nor does private industry offer security to its engineering employees. Hence technical graduates are not attracted to private industry. They prefer government jobs even though these necessitate a period of initial idleness. The Government of India, the universities and Indian industry are cognizant of the situation and are seeking ways and means to remedy it.

Research Institutes

Side by side with the building of new universities and new technical institutes, the Government of India, since independence in 1948, created the Department of Scientific and Industrial Research, "to supervise and coordinate research work undertaken by the State and private institutions." Subsequently this department became a part of the Ministry of Natural Resources and Scientific Research which was established early in 1954.

The Council of Scientific and Industrial Research is an autonomous government body whose purpose is "establishing, maintaining and managing laboratories and institutions devoted to scientific and industrial research." The Council awards research scholarships and fellowships and utilizes the results of research for the development of industries. It also publishes scientific papers and journals to disseminate information on scientific and industrial matters.

The activities of the Council are financed mainly by the Union Government. Grants of lands and buildings are given to the Council whenever it plans to establish a research institute. Since independence, fourteen national research laboratories, which undertake both fundamental and applied research, have been established.

To show the importance which India attaches to research, it is well to note that the Council is administered by a government body with the Prime Minister as President and the Minister for Natural Resources and Scientific Research as Vice President. Other members of this governing body include representatives of the Ministry of Finance, of Business, and of Industry. The governing body receives advice from a board consisting of nineteen men of whom nine are eminent scientists. It has twenty-five research advisory committees in various fields.

Besides the newly established institutes of research there are others either entirely privately supported or financed partly by the Union Government.

The author would like to call particular attention to the laboratories of the Indian Academy of Science (Raman Institute) in Bangalore. Sir C. V. Raman is a Nobel Prize Laureate in physics. He is, without a doubt, the greatest Indian physicist. He gave all his accumulated funds as well as the Nobel Prize money to establish this institute of research which in five years published 94 papers describing the researches of Dr. Raman and his colleagues in various fields of physics with particular emphasis on crystal structure, luminescence, irridescence and other optical phenomena. The author

had the pleasure of spending an afternoon with Sir C. V. Raman, a gentleman in his middle sixties with the enthusiasm of a youth for his institute and its researches. The only support which he or his institute receive from the Union Government is his salary of about $400 as National Professor of Physics. He shares this salary with his colleagues, taking for himself only what is absolutely necessary to supply his and Mrs. Raman's very simple wants. He refuses any government help for his institute because he wants to keep it strictly a private venture. His other sources of income are little contributions from friends and admirers. I have never met an individual more devoted to the cause of science. I promised Dr. Raman to tell his story to America in the hope that it will touch the heart of some philanthropists or an organization which might give his institution the needed financial backing.

This paper may be summarized as follows:

a. India, since independence, has forged ahead in technical education both through its own efforts as well as with the aid of other friendly nations including the United States.

b. The students in India are highly intelligent because they are selected on the basis of an entrance examination. They do not suffer distractions arising from extra-curricular activities. They shun menial labor.

c. Indian universities offer courses not generally offered by American universities. These include the diploma courses and the refresher courses.

d. A new experiment in international graduate work has been established in Roorkee, namely the "Water Resources Development Training Course."

e. In general the faculties of Indian universities need improvement which the Indian Government is doing its utmost to effect.

f. The equipment for undergraduate study is adequate. However, the equipment for graduate study and research leaves much to be desired.

g. The cost of technical education in India is very low as compared with its American counterpart. However, when attuned to the income of Indian parents it is very high.

h. Opportunities for employment of technical graduates are not as good as they are in the United States.

i. India since independence has established several research institutes, universities, and technical institutes. The Union Government of India spends relatively much more on technical education than does our Federal Government.

j. There are private institutes of research which are struggling hard to make ends meet. Among these is the Raman Research Institute at Bangalore.

Footnote

[1] Note: The Vice Chancellor in an Indian University corresponds to the President of an American University. The Chancellor is the Governor of the State in which the University is located.

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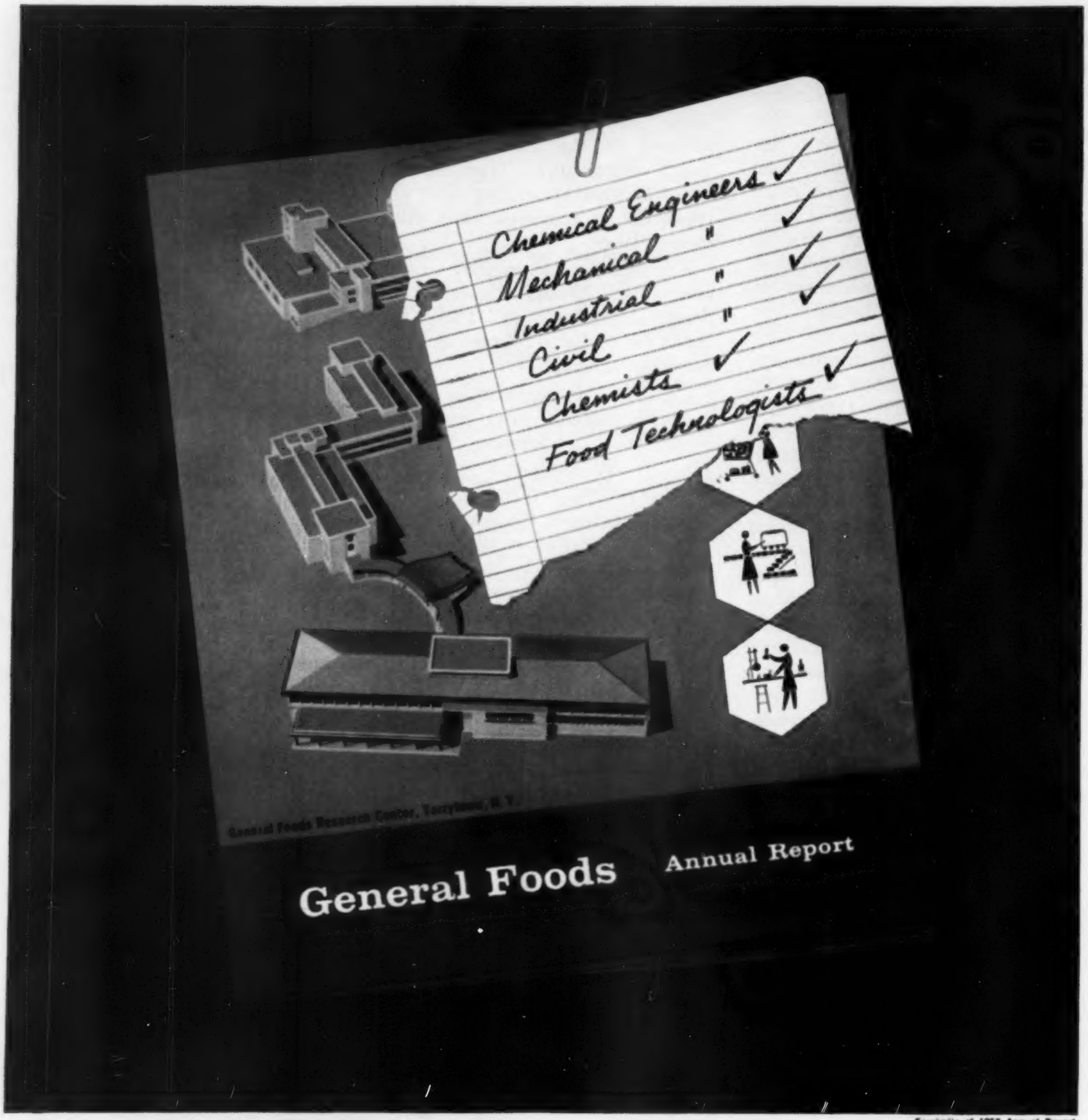

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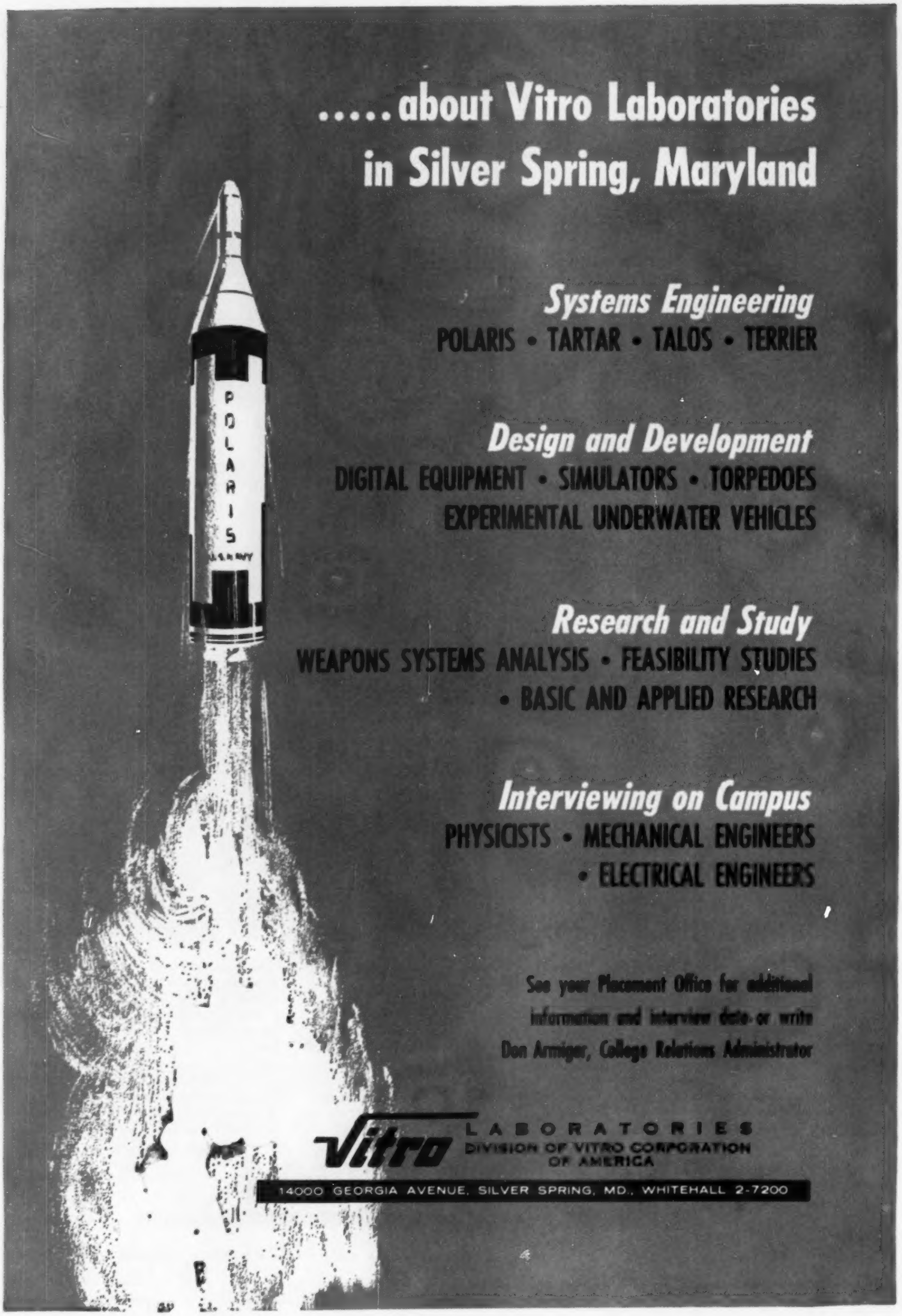
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COLLEGE NEWS

Edited by John Hughes, EP '64

PROFESSOR JOHNSON TO JOIN ENGINEERING COLLEGE FACULTY

Herbert H. Johnson has been appointed Associate Professor of Mechanics and Materials in the College of Engineering at Cornell University.

Professor Johnson comes to Cornell after serving for three years as an assistant professor in the department of metallurgy at Lehigh University. He will teach undergraduate and graduate courses and will carry on research on high strength steels.

Ed Schulman

Professor Herbert Johnson

Professor Johnson, a native of Cleveland, received the Bachelor of Science, Master of Science and Doctor of Philosophy degrees from Case Institute of Technology. He served as a research assistant for five years while doing graduate work there.

He has recently specialized in the study of hydrogen embrittlement, stress corrosion, and notch-sensitivity in steels. He has published several articles on these topics in professional journals. Professor Johnson is a member of the American Institute of Mining and Metallurgical Engineers, American Society for Metals, American Welding Society, Iron and Steel Institute and Institute of Metals.

AUTOMATION EFFECTS ON WORK ENVIRONMENT STUDIED

Computer automation causes changes in work environment and job satisfaction, but they are changes very similar to those which occur normally and without such automation, a study published at Cornell University reveals.

The study is the first to compare changes caused by computer automation with changes brought about by ordinary work modifications. It appears in the current issue of Industrial and Labor Relations Review, a publication of Cornell's New York State School of Industrial and Labor Relations.

Professor Einar Hardin of the University of Michigan, author of the article, compared the impact of automation on work environment and job satisfaction after a computer was installed in the statistical department of a medium-sized casualty insurance company.

Workers in departments directly affected by installation of the computer and in departments unaffected were questioned. Changes due to computer automation reported by workers in affected departments were similar to those reported by workers in unaffected departments. The latter experienced only ordinary work modifications.

Professor Hardin questioned employees in the two types of departments on their perception of computer impact on their jobs, net job change, feelings about job change and job satisfaction. He also tested the workers concerning computer impact on specific job aspects such as amount of security, supervision, skill and responsibility, degree of accuracy and chance for promotion.

"Affected departments reported more computer impact on the job as a whole and on specific job aspects," he said, "but showed very few significant differences in the frequency and direction of net change in the same specific job aspects."

HOT MACHINING REMOVES METAL EFFICIENTLY

Research by a Cornell University professor of mechanical engineering has shown that matching metals in the 73 to 1200 degrees Fahrenheit range increases the efficiency of metal removal by cutting tools.

The results of metal turning tests performed at Cincinnati Milling Machine Company under United States Air Force sponsorship by William Pentland, Assistant Professor of Materials Processing, Sibley School of Mechanical Engineering, and colleagues at the company's laboratories were disclosed recently at a meeting of the Western Section of the American Society of Tool and Manufacturing Engineers in Los Angeles.

A paper, prompted by increased use of high strength materials in quantity by today's manufacturers, was read by Assistant Professor Pentland. He was in charge of the work as a member of the company's research staff and was assisted in the testing by the co-authors of the paper, Jens L. Wennberg, senior research engineer, and Clarence L. Mehl, senior research engineer in the physical research department, Cincinnati Milling Machine Co.

The objectives of tests performed were: to examine the influence of elevated temperatures on machining curved surfaces, and to determine the effects of heat on machineability of high strength alloys; to investigate and develop controlled heating methods suitable for application in machining operations, and to measure the effects such elevated temperature machining might have on the metallurgy and geometry of the workpieces.

Ed Schulman

Professor William Pentland

According to Professor Pentland, it appears that for continuous cuts, such as turning on a lathe, ceramic tools with their temperature resistant properties have a sound application in hot machining.

No detectable change in microstructure was apparent on examination of hot machined specimens, but microhardness checks showed tempering occurs when the original tempering temperatures are exceeded. The depth to which tempering occurs varies with the material and duration of heating. Surface finish was as good or better at the elevated temperatures, though some surface oxidation was apparent at the higher temperatures used. There are no excessive safety or health hazards involved in hot machining because localization and control of heat can be achieved without many of the disadvantages of induction, and there are many ways available of controlling the heat source.

Lathe finishing operations demand that tolerances be strictly maintained, while roughing operations are rated with metal removal rates most important. Hot machining, Professor Pentland recommends, should be applied in roughing operations on high strength materials where conventional cutting is difficult.

HIGH VOLTAGE RESEARCH BEGUN AT CORNELL

The first electrical testing station for extra high voltage underground cable; the result of seven years of cooperation between manufacturers, users, and Cornell University, has been officially opened at Cornell.

High voltage will be used to conduct field tests of severe loading conditions on underground cable systems designed for 354,000 volt operation. During subsequent phases of the project the test voltage will be increased gradually to 500,000 volts to further determine the characteristics of the system.

The station, a major step in electrical industry research, was conceived, developed, and built by private enterprise. It involves the cooperation of electric utility companies and cable, terminal, and pressurizing equipment manufacturers. Total cost of the station is estimated at $3,000,000. Its opening marks the end of the first phase of the project conceived in 1953. At that time the upsurge of overhead transmission voltages and station machine capacity made necessary the development of underground cable systems that could satisfactorily operate and carry loads of 500,000,000 voltamperes.

Since 1953 the manufacturing companies involved have developed cable and accessories through research and testing in their laboratories with the utility companies and the associations providing for the construction of the field laboratory at Cornell.

The second phase of the project which will probably require a period of three years involves energizing the systems. During the first two years the voltage will be raised in gradual steps from 345,000 to 415,000 volts with loading temperatures comparable to commercial operating conditions. Following the two-year period will be tests with elevated temperatures and voltages up to 500,000 volts to further determine the characteristics of the system.

TECHNIBRIEFS

Edited by Richard Epstein, EE '63

NICKEL-STEEL PROMISES SAFER LIQUID GAS TRANSPORTATION

A steel which keeps its strength properties at extremely low temperatures was recently tested successfully. This material, a 9 percent nickel-alloy steel, will be used in the economical storage and transportation of liquified gases at temperatures as low as −320 degrees Fahrenheit.

Tests have been conducted on several different types of containers under varying conditions. One vessel, simulating a type that might be used for shipboard transport of liquid methane, was filled with liquid nitrogen at −320 degrees Fahrenheit and tested by the repeated crashing impact of a 4340 pound steel wrecking ball swung against the side of the vessel from varying heights. The kinetic energy of the heaviest impact was slightly more than 82,000 foot-pounds. Thus, economical 9 percent nickel-steel vessels can withstand impacts far beyond any which are likely to occur in service. Another test was conducted with a vessel which could be used for land-based storage of liquid nitrogen. Tests proved that the new nickel-steel can withstand a stress of at least six times the design stress in this application.

Development of this steel was spurred by increased demand for containers of low-temperature liquified gases. The steel industry wanted a safer means to store thousands of tons of liquid oxygen which it uses daily in melting operations. A growing user of the alloy is the missile industry, which needs safe liquid oxygen storage. Another new use for low temperature containers is the storage and transportation of methane from oil fields to consumers. This transportation over long distances is only feasible when the gas is first liquified.

Cyrogenics, a new low-temperature alloy industry, has evolved through the combined efforts of The International Nickel Company, Incorporated, the Chicago Bridge and Iron Company and the United States Steel Corporation.

Operation Cryogenics

Engineer points to ductile rupture in the corner of a 9% nickel steel rectangular vessel which was filled with liquid nitrogen and subjected to a series of impacts at —320° F with a 4340-pound wrecking ball.

NOVEL CARDIAC RESUSCITATOR SUMMONS THE DOCTOR BY RADIO

Westinghouse Electric Corporation has announced plans to produce a cardiac resuscitation system combining two new transistorized instruments.

The first is a small, portable, self-powered cardiac pacer. The pacer is essentially a compact source of periodic electrical stimuli whose pulse rate and amplitude are adjustable over wide ranges. One of its two control knobs permits the pulse rate to be varied from twenty-five to two-hundred fifty beats per minute, while a second knob permits pulse amplitude to be adjusted over a range of zero to twenty-five volts at .27 amperes, or over a second range of zero to two-hundred fifty volts at an output current of a tenth of an ampere. Since the instrument contains its own source of electrical energy in the form of mercury batteries, the pacer can be employed in circumstances in which a conventional source of electric power is not available. To ensure that batteries, transistors, contacts and other circuit elements are functioning properly, the pacer can be tested by touching its output leads to a self-test terminal. Another indicator of proper performance is a small, bright lamp which flashes every time a pulse of electricity is triggered. Weighing about two pounds, and measuring 3″ x 5″ x 2½″, the pacer fits in a small handbag along with the chest plates, electrode paste and tension strap that form a full complement of equipment for emergency service.

The second unit is a bedside monitoring unit. Designed in much the same manner as the pacer, the cardiac monitor will also be fully transistorized in order to minimize its bulk, weight and susceptibility to failure. When connected to the pacer, this 5″ x 8″ x 9″ unit will constantly monitor the patient's heartbeat and in the case of heart arrest, will cause the pacer to begin stimulation of the patient's heart at a preset rate and amplitude. A unique feature will be the inclusion of an integral radio transmitter which will broadcast a coded alarm signal in case of emergency. Thus, the doctor, listening to a receiver, will be

notified immediately when the patient needs assistance.

ULTRAVIOLET LIGHT USED TO MEASURE ULTRA-LOW PRESSURES

A new laboratory tool for the measurement of pressures less than one-thousandth of one-billionth of atmospheric pressure at the earth's surface has been developed by scientists at the Westinghouse Research Laboratories. The device, known as a photomultiplier ion gauge, was constructed as part of an ultra-high vacuum research program supported by the U.S. Atomic Energy Commission.

The new instrument's advantage over conventional low-pressure-measuring devices is that no hot filament is used in the measuring process. Conventional instruments which measure extremely low pressures, do so by placing electrical charges upon the gas particles remaining in a vacuum system and counting the rate at which these charged particles, or ions, form. These charges come from electrons that are boiled off the surface of a hot tungsten filament that is located inside the vacuum system and in contact with the gas being measured. In many instances, the gas interacts with the hot filament surface, breaking the gas down and converting it to an entirely different substance. Thus, the very act of measuring the gas pressure contaminates the gas and upsets the entire experiment.

Instead of using a hot surface to produce the required ionization of the gas, the new device utilizes a beam of ultraviolet light. The light is beamed upon a metal surface which has the ability to release electrons under the stimulus of the ultraviolet rays. These electrons are guided to a photomultiplier which multiplies the electrons' speed and number. These electrons then form the ions which are collected and counted in the usual fashion.

The photomultiplier ion gauge will be useful in key ultra-high vacuum research experiments, being ideally suited to low-pressure studies of hot filament-gas interactions such as those encountered in the ordinary fluorescent lamp, in electronic tubes and in thermionic energy converters.

Pressures measured by the device are similar to those encountered in space at distances between 50 and 650 miles above the surface of the earth. The new gauge already has found use in pressure measurements and other experiments aimed at measuring the concentration and understanding the interactions of the particles found in outer space, through duplication of outer space conditions in the laboratory.

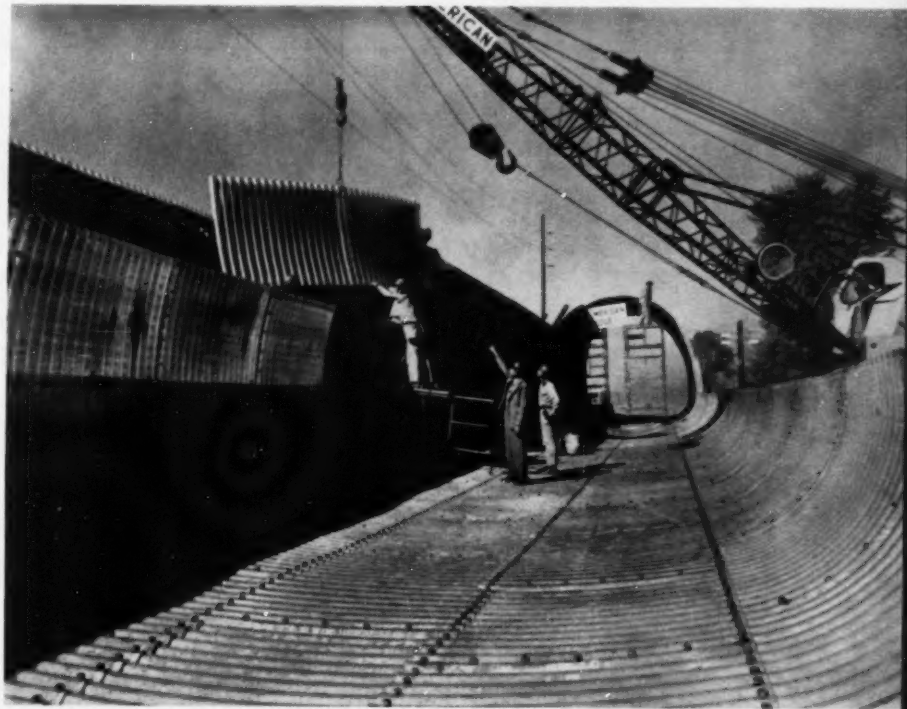
CULVERTS TO CARRY HIGHWAY TRAFFIC

A king-sized culvert now being erected for use as an automobile underpass will speed up construction of new highways and save the taxpayers' money at the same time.

United States Steel Corporation's American Bridge Division is installing what are thought to be the two largest pipe-arch structures ever fabricated. Upon completion, they will form a two-lane underpass for a new interstate highway. Each unit of the twin structure will be 334 feet long. Slightly egg-shaped, the completed tunnels will be approximately twenty feet wide and seventeen feet high.

Requiring far less time to erect than a conventional bridge-type underpass, the corrugated steel units were shipped prefabricated to the construction site. A ten-man crew can complete the installation job in three to four weeks whereas engineers estimate that building a conventional underpass would require three months or more.

Two hundred forty-seven tons of five gauge copper-bearing galvanized steel were formed to the specified shapes at the fabricating plant. Individual steel plates were bolted together to form large sections weighing as much as five tons. The sections were then moved into position at the site. The joined sections form a pipe arch which appears to have been flattened on the bottom. The completed tunnels will feature fourteen foot concrete roadways and pedestrian walkways—each tunnel carrying traffic in one direction.



United States Steel

Swinging a corrugated steel plate section into place, American Bridge Division workmen erect the side of a pipe-arch vehicular tunnel destined to carry traffic under Interstate highway 74 near Morton, Illinois. Two of the tunnels, thought to be the largest pipe-arch structures ever fabricated, are being built side by side to carry two concrete lanes of traffic.

FIFTY YEARS AGO IN THE ENGINEER

Edited by Jeremy Shapiro, ME '62

The marked inability, on the part of engineering students, to handle problems requiring the application of even the most elementary mathematical principles, is one of the greatest difficulties which confronts the technical educator. This is rarely due to inefficient instruction in the early part of the technical course, but usually to the attitude of indifference with which the average student views the problem of assimilating such apparently dry and impractical knowledge. It seems to have no immediate relation to the more practical side of the technical education, and hence may be put aside and forgotten as soon as examinations are over. The result is that the student does not attempt to keep his mathematical mind sharpened by continual practice in the solution of practical problems, so that when he is confronted with a task involving the use of some basic mathematical principle, he finds himself seriously handicapped by lack of preparation.

It is a matter of no slight degree of importance to the engineer to have the elements of mathematics, at least, at his fingertips, for immediate use when required. To this end it should be the purpose of every technical student to build his mathematical intelligence on a sound foundation. *The Sibley Journal, January, 1911*

Though many systems of wage payments are already in existence, it may be said without fear of contradiction that the ideal one has not yet been promulgated. However, since there is as much in the proper selection and the subsequent carrying out of such a system as in the system itself, the further statement may be made with almost equal positiveness, that any of the well known systems of wage payments will, when properly applied, be found capable of meeting average conditions quite satisfactorily.

It is a common, though mistaken notion, that the interests of employer and employee lie apart, whereas, as a matter of fact, their real interests are identical. The ultimate aim of each is to make a fair profit on his capital, the employer on his product, the employee his labor. With this end in view the employer desires low costs, while the employee naturally wants high wages.

When these two features are combined as they should always be, both parties will be satisfied. To accomplish these results then, the employer must secure a proportionate share of the business transacted in his product, which can, however, only be obtained through the medium of reasonable prices to his customers.

At this point it becomes necessary, in order to obtain a clearer insight into the subject, to ascertain the process of determining selling prices. The several items entering in will therefore be discussed as follows: Direct Materials Cost plus Productive or Direct Labor plus Indirect Factory Expense is equal to Factory Cost; Factory Cost plus General Expense is equal to Commercial Cost; and Commercial Cost plus Profit is equal to Selling Price. *The Sibley Journal, January, 1911*

The aviator is reported to have sent dispatches for a distance of six miles from an aeroplane in the air, and he is reported as being confident of being able to telegraph in this manner for a distance of sixty miles or more. The value of a practicable combination of wireless telegraphy and aviation in military maneuvers would be very great, as it is said that (the) . . experiments have made a deep impression on the military experts of France. *The Sibley Journal, January, 1911.*

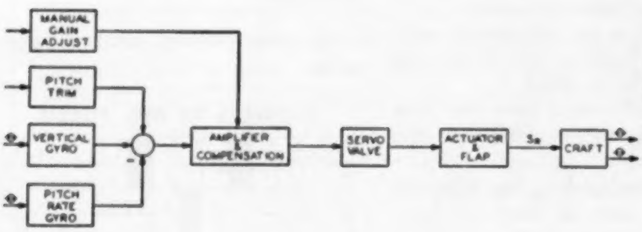
The Cooper-Hewitt lamp consists of a glass tube containing mercury, and having electrodes at each end. In order to start the lamp, the tube is tilted, and the thin stream of mercury forms a path for the current. The tube being now returned to the inclined position and the circuit interrupted; the arc forming vaporized sufficient mercury to fill the tube with vapor, which then acts as a conductor, giving forth abundant and penetrating light of a greenish blue color, and containing absolutely no red rays. This unique color has both its advantages and disadvantages. The absence of red rays gives a ghastly appearance to the features of persons viewed by this light, thus debarring it from use in residences, assembly halls, theaters and the like. For warehouses, piers, etc., its diffusing and penetrating qualities, and the absence of shadows, render it effective. It is also coming into use in steel works, and for other manufacturing purposes where it is not subjected to mechanical injury. It is not suited for lamps which have to be moved very much, as the tubes get brittle with age. The light seems to have a peculiar restful effect on the eyes, and for this reason is largely used in drafting rooms; the lines and figures on blue prints being brought out more prominently than by daylight. For photographic work it is unexcelled. *The Sibley Journal, December, 1910.*

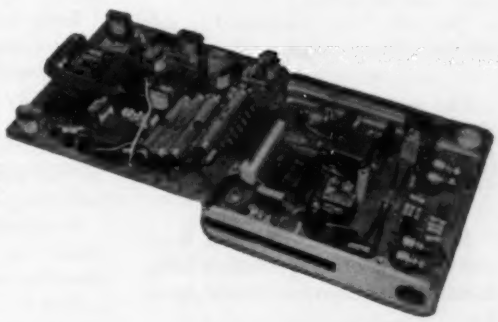
PROBLEM: HOW ELECTRONICS KEEPS A HYDROFOIL CRAFT ON ITS TOES

Hamilton Standard's Electronics Department is currently developing the automatic stabilization system for Grumman Aircraft's exciting hydrofoil boat. This all-aluminum, 80-ton test design is expected to reach speeds of 60 to 80 knots by means of reducing its drag through the automatically controlled "lift" of hydrofoils. For peak efficiency, the incidence of these foils must be continuously controlled so that the center of gravity will remain steady as wave height and direction of flow change . . . through every kind of sea.

As you can see, the engineering requirements implicit in designing an automatic control system for such a craft created a variety of problems. Engineers had to consider automatic pitch stability augmentation during take-off, cruise and landing; manually adjustable trim control devices to allow the pilot to set desired trim in pitch attitude; pitch trim control from level to eight degrees bow-up and within ± .25 degrees of reference. In addition, the control, which will require 115 ± 10V RMS at 400 ± 20 CPS, had to be designed so that open or short circuit failure of any one component would not put large reference voltages in circuit areas resulting in large control surface displacements.

Making use of its experience acquired in engineering the Automatic Stabilization Equipment for helicopters such as Sikorsky's S-61 the Electronics Department developed the lightweight, highly transistorized gear shown below incorporating the latest state-of-the-art packaging and circuitry techniques. The block diagram on the left below shows the breakdown of the major parts of the system—amplifier and compensation, vertical gyro package and rate gyro. Space prevents detailed explanations of its operations but if you would like to work on similar challenging undertakings talk with our campus representative about your career aspirations. Write for your copy of our brochure, ENGINEERING FOR YOU AND YOUR FUTURE, to Mr. R. J. Harding.





HAMILTON STANDARD DIVISION

an organization dedicated to *Scientific and Engineering Excellence*

UNITED AIRCRAFT CORPORATION

WINDSOR LOCKS, CONNECTICUT

STRESS *and* STRAIN...

Edited by Delia Corkey, EP '64

An inmate of a certain insane asylum, feeling that he had recovered enough to be released, appeared before the desk of the superintendent. After he was partially examined he was asked the following question:

Superintendent: "If we discharge you, will you promise to let women and liquor alone?"

Inmate: "Yes sir."

Superintendent (beckoning a guard): "Lock him up; he's still crazy."

• • •

We've just learned a secret method for returning from Las Vegas with a small fortune: go with a large one.

• • •

He'd shown her his etchings, and just about everything else in his apartment and, as Jack poured the last of the martinis into their glasses, he realized the moment of truth with Louise had arrived. He decided on the direct verbal attack.

"Tell me," he said smoothly, fingering a lock of her hair, "do you object to making love?"

She turned her lovely eyes up to his. "That's something I've never done," she said.

"Never made love?" cried Jack, appalled at the waste of magnificent raw material.

"No, silly," she answered in soft rebuke. "Never objected."

• • •

The reason girls today will do things their mothers wouldn't think of doing is that their mothers didn't think of doing them.

• • •

Here's a tip for your next exam—if you're poor at spelling, it helps a lot if your handwriting is lousy too.

• • •

History credits Adam and Eve with being the first bookkeepers, because they invented the loose-leaf system.

• • •

Girls who don't repulse men's advances, advance men's pulses.

A man who looked like a high-powered business executive began to drop in at Tim's regularly, and his order was always the same: two martinis. After several weeks of this, Tim asked him why he didn't order a double instead of two singles.

It's a sentimental thing," the customer answered. "A friend of mine died a few weeks ago, and before his death he asked that when I drink, I have one for him, too."

A week later, the customer came in and ordered only one martini.

Tim asked, "Why only one, what about your dead buddy?"

"This is my buddy's drink," the man replied as he gulped the martini down. "I'm on the wagon."

• • •

These days the necessities of life cost you about three times what they used to, and half the time you find they aren't even fit to drink.

• • •

Generally speaking, women are.

• • •

Our Favorite Cynic Defines For Us:

anatomy as something that everybody has, but looks better on a girl.

both *bigamy* and *marriage* as having one wife too many.

husband as an unfortunate who began by handing out a line and ended up by walking it.

individualist as a man who lives in the city and commutes to the suburbs.

intellectual girl as one who can think up excuses that her boyfriend's wife will believe.

kiss as an application for a better position.

• • •

Some people have no respect for age unless it's bottled.

• • •

It's no fun to kiss a girl over the phone unless you happen to be in the same booth with her.

We know a man who thinks marriage is a 50-50 proposition, which convinces us that he either doesn't understand women or percentages.

• • •

This year's college graduates deserve your sympathy. Almost anywhere they look for work, they run a terrible chance of finding it.

• • •

"Look at the way these young people dress today!" snorted the judge at the horse show to another judge standing next to him. "See that thing with a poodle haircut, blue jeans, and shirt hanging out. I can't even tell whether it's a boy or girl!"

The judge he was talking to coldly answered, "I can assure you it is a girl—she is my daughter."

"My apologies," mumbled the first judge, "I had no idea you were her father."

"I'm NOT," snapped the parent, "I'm her mother."

• • •

Overheard at Cafeteria:

First Cook: "Hey, the garbage man is outside."

Dietician: "OK., tell him to leave three cans today."

• • •

The gods gave man fire and he invented fire engines. The gods gave him love and he invented marriage.

• • •

To most writers, sex is a novel idea.

ANSWERS TO DEC. PUZZLE

J	I	B	E		A	M	P		E	U	L	E	R
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O	S	P	R	E	Y		U	N	T	E	A	C	H
			O	R		I	M	E				U	A
			P	I	A	N	O				P	A	T
P	R	A	T	E	R		B	A	A		A	T	E
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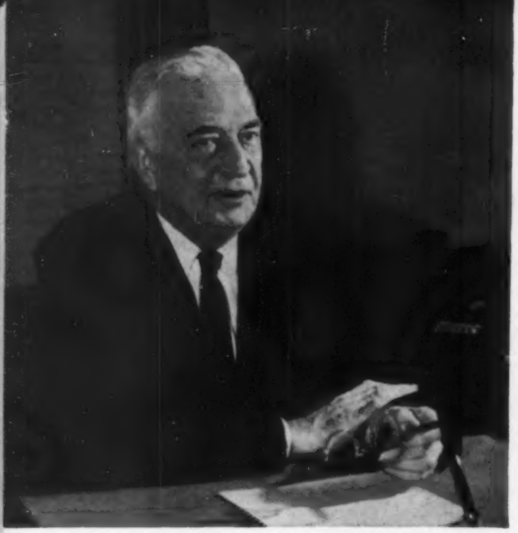

One of a series

Interview with General Electric's Earl G. Abbott, Manager—Sales Training

Technical Training Programs at General Electric

Q. Why does your company have training programs, Mr. Abbott?

A. Tomorrow's many positions of major responsibility will necessarily be filled by young men who have developed their potentials early in their careers. General Electric training programs simply help speed up this development process.

In addition, training programs provide graduates with the blocks of broad experience on which later success in a specialization can be built.

Furthermore, career opportunities and interests are brought into sharp focus after intensive working exposures to several fields. General Electric then gains the valuable contributions of men who have made early, well-considered decisions on career goals and who are confidently working toward those objectives.

Q. What kinds of technical training programs does your company conduct?

A. General Electric conducts a number of training programs. The G-E programs which attract the great majority of engineering graduates are Engineering and Science, Manufacturing, and Technical Marketing.

Q. How long does the Engineering and Science Program last?

A. That depends on which of several avenues you decide to take. Many graduates complete the training program during their first year with General Electric. Each Program member has three or four responsible work assignments at one or more of 61 different plant locations.

Some graduates elect to take the Advanced Engineering Program, supplementing their work assignments with challenging Company-conducted study courses which cover the application of engineering, science, and mathematics to industrial problems. If the Program member has an analytical bent coupled with a deep interest in mathematics and physics, he may continue through a second and third year of the Advanced Engineering Program.

Then there is the two-year Creative Engineering Program for those graduates who have completed their first-year assignments and who are interested in learning creative techniques for solving engineering problems.

Another avenue of training for the qualified graduate is the Honors Program, which enables a man to earn his Master's degree within three or four semesters at selected colleges and universities. The Company pays for his tuition and books, and his work schedule allows him to earn 75 percent of full salary while he is going to school. This program is similar to a research assistantship at a college or university.

Q. Just how will the Manufacturing Training Program help prepare me for a career in manufacturing?

A. The three-year Manufacturing Program consists of three orientation assignments and three development assignments in the areas of manufacturing engineering, quality control, materials management, plant engineering, and manufacturing operations. These assignments provide you with broad, fundamental manufacturing knowledge and with specialized knowledge in your particular field of interest.

The practical, on-the-job experience offered by this rotational program is supplemented by participation in a manufacturing studies curriculum covering all phases of manufacturing.

Q. What kind of training would I get on your Technical Marketing Program?

A. The one-year Technical Marketing Program is conducted for those graduates who want to use their engineering knowledge in dealing with customers. After completing orientation assignments in engineering, manufacturing, and marketing, the Program member may specialize in one of the four marketing areas: application engineering, headquarters marketing, sales engineering, or installation and service engineering.

In addition to on-the-job assignments, related courses of study help the Program member prepare for early assumption of major responsibility.

Q. How can I decide which training program I would like best, Mr. Abbott?

A. Well, selecting a training program is a decision which you alone can make. You made a similar decision when you selected your college major, and now you are focusing your interests only a little more sharply. The beauty of training programs is that they enable you to keep your career selection relatively broad until you have examined at first hand a number of specializations.

Furthermore, transfers from one General Electric training program to another are possible for the Program member whose interests clearly develop in one of the other fields.

Personalized Career Planning is General Electric's term for the selection, placement, and professional development of engineers and scientists. If you would like a Personalized Career Planning folder which describes in more detail the Company's training programs for technical graduates, write to Mr. Abbott at Section 959-13, General Electric Company, Schenectady 5, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC